

Voices of Experience

Air Show Veterans on Flying Low-Level Aerobatics



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INTRODUCTION

As a service to ICAS members, Air Show Hall of Fame member and longtime air show performer Deb Gary spent several months interviewing veteran air show pilots on a wide variety of issues and topics unique to air show pilots flying in the low level aerobatic environment. From formation flying, comedy acts, wingwalking and inverted ribbon cuts to sequence design, induced drag, in-flight emergencies and energy management, more than two dozen of the most experienced voices in the air show business offered their frank and unvarnished advice and insight based on what they've learned on their own and from their mentors.

This document is about how things work, how they feel, how they look, what veteran pilots have learned, and how they learned it by doing it right and doing it wrong. It contains information that air show pilots can visualize and remember easily. It is not a technical document, but – instead – seeks to bring air show pilots into the cockpit to provide a colleague's perspective on the demands of air show flying. It includes many different viewpoints and has been developed, quite deliberately, as an organic document that changes and evolves over time.

Although we expect this finished document to be a valuable information resource and useful tool, it is not intended to be a "how-to" document. Low-level aerobatic flying is specific to the show site, pilot, aircraft, weather conditions and a host of other factors. This type of detailed, first-person narrative will be helpful to some, but it is intended to complement – not replace – practice, dual instruction, one-on-one coaching, and good judgment.

Nor is this document intended to be an exhaustive discussion on all of the major air show performance concerns involving all of the leading practitioners. The pilots interviewed represent a broad spectrum of air show pilots, but the perspectives are necessarily limited and there is no intention to suggest that their opinions represent the definitive word on any of the issues covered.

ICAS would like to thank all of the veteran air show pilots who were so generous with their time, experiences and insights as we worked during the last year to build this document. "Voices of Experience" was built entirely on their willingness to share the lessons they have learned during many decades of air show flying.

Finally, ICAS expects and wants this document to be an organic document that evolves and grows over time. Deb Gary has given us an enormously strong, thorough start, but the material will change. Techniques and tactics will change. Conventional wisdom will change. And, as it does, ICAS intends to update this material to reflect those changes.

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ATTITUDE AND EXPERIENCE

Air show flying is a dynamic art form. It is physically, mentally and emotionally demanding. Extreme maneuvering in the low-level environment demands skill and focus, plus years of practice and an attitude of caring about yourself, your airplane, and the people around you. The behavior of each individual performer can affect the fate of the entire air show community, so air show pilots monitor, evaluate, coach, encourage and mentor each other.

Kent Pietsch

I don't care if you have a dime or a million dollars, it should be your responsibility to help nurture this business. The business has to be important to you because any one pilot can screw this business up. And attitude is everything. That is something that has to be discussed with new pilots.

If they come in with a preconceived notion [that] they're a great pilot and they don't have the reasoning to want to learn more, then they are in trouble. I personally have a lot to learn every time I fly.

This is an entitled society and so many people think they are infallible when they are not. It is somebody else's fault if they get hurt. That is what some people think. But, when you are flying your airplane, you are the one who is responsible. That is the deal. Nobody else can do it.

At the end of an ACE evaluation, I think you should tell them, "I did everything I can for you. It's all up to you now. I am here to evaluate you and I don't mind mentoring you, too. And I don't mind helping you to get going on the right path. But you are flying that airplane. And it is up to you not to be an ass and kill yourself. But I can't tell you not to. If you want to do that, you are going to do that. But we are trying to give you every opportunity not to, and to help out every way that we can."

Bob Bishop

I was an ACE for twenty some odd years. And one of the things I always looked at, number one, was how did they learn aerobatics? What is their training level? Are they coming to me after they've only had two hours of training and ten hours of practice? I've actually run into that. So, when you come to take an evaluation, you had better know how to do aerobatics as if it is second nature.

There are a lot of things to know about putting your routine together and executing it. But if you don't know how to do loops and rolls to the point that you don't have to think about it, you're probably not qualified. I actually would tell people, "I cannot continue this evaluation. You are not qualified. You have not spent enough time at this. You do not have enough experience to be applying for this."

To me, you need at least a minimum of a ten-hour aerobic course and/or some kind of a mentoring situation, where there is some kind of mentor who is there, actually working with you, who is able to start you up high and work you through all this stuff. Because I've watched fatal routines with new people, and I can guarantee you they did not have enough aerobic experience to start with.

Once, I was watching a T-6 routine and went, "Oh God. No, stop! Please somebody, stop this guy." I could see what was happening. The guy did not know enough about aerobatics. He was flying a T-6. He was in fear, I guarantee you. I taught aerobatics for a couple thousand hours and what I know is that the number one mistake made by a novice is that, under fear, they will revert to old patterns, and they will begin pulling back on the stick to hurry a roll.

Pulling back on the stick hurries a turn. It does not hurry a roll... or, at least, not enough. The tendency for people in a roll: if they get frightened, they forget to keep the ailerons all the way over. I've seen this over and over from hundreds of hours of watching people. When they first start trying to do aerobatics, the single, biggest, fatal error and the single, biggest error in training is that they don't remember to keep the stick over. And they forget that that back pressure will not hurry the roll. It won't get you out of trouble. It will get you into it.

This guy I watched, buried himself off of a barrel roll. But he had almost hit the ground in a reverse Cuban and – instead of stopping – he went right into a barrel roll and I could see what happened. He was pulling so hard on that airplane that he wasn't rolling it. He went in almost 90 degrees. It was that bad.

So that is my first thing: have enough experience. Make sure you have the training. Don't come to an evaluation unprepared. Just because you don't kill yourself doesn't mean I am going to pass you.

I find that rational fears are good. It is good not to jump off a tall building without a parachute. That is a good rational fear. But, when we do things in fear, we wind up getting exactly what we feared...fear as a boomerang. So I think one has to be able to fly in a condition of heightened alert, but if you are really frightened, you shouldn't be doing it. I know that my concentration level would go up so high before doing my routine that I would actually kind of go into a concentration trance. People would talk to me on the ground before [my performance] and I would not remember a damn thing they said.

I think people should come to an evaluation qualified to fly air shows. I think competition is a great way to do it and, if not, then just a lot of practice time with someone tutoring or mentoring you. I think trying to find a mentor in this business is a good thing. Charlie Hillard was a mentor to me. We worked for a year

together. What a deal! I am quite convinced that helped me set my attitude and was the thing that kept me out of trouble.

Warren Pietsch

Aerobatics is a free style type of flying that takes dedication and passion that makes you the type of pilot that you are going to be. You are either going to be cocky and a show off, which – in my opinion – makes you dangerous. Or you are going to be a guy that is really interested in being a good pilot and wants to learn that stuff and get better and better.

New air show acts come and go. There are some guys that you can't teach, and guys that don't want to learn from anybody else. They don't want to listen. I don't know how you are going to fix those guys. But if you watch the air show acts, you see some guys in an air show and you say, "Well, he ain't going to be around long." And those are the guys that you can't teach, the guys that do things like so many of them that have been hurt, or guys that didn't want to learn from anybody else. They didn't want to listen. I don't know how you are going to fix that.

Air show flying is a risky business. When you aim an airplane straight down at the ground 300 feet up, it's not as safe as going straight and level. It just isn't. There is no way to make it that way. But there are ways to make it better.

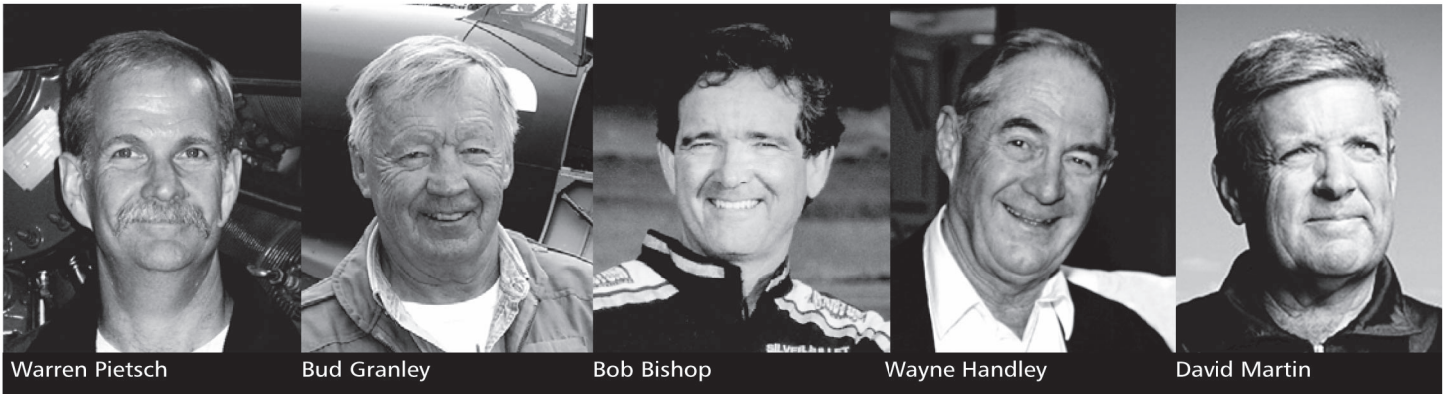
Bud Granley said what he wanted to promote was the buddy system, where guys take on the responsibility to go give the guy an opportunity to listen. Or go to him at the beginning of the show to say, "Hey, would you watch my act and critique me? I respect you. Please watch my act and tell me what I did." And mean it when you say that. Then, when you are asked to do that, take the responsibility to stand and watch the guy's show and critique him. Come back to him afterwards.

One year at Reno, I got pretty close to the ground and Jim Peitz, who is a great buddy of mine, came over and said, "How far was your wingtip off the ground?" I said, "Eight inches." He said, "Exactly! Don't do that anymore." And he said, "I'm glad to know that you knew where it was. There is no reason to do that." And you know what? He was right. You are feeling your oats and everything is going great. And sometimes you get a little carried away.

There is no question that everybody has an ego and air show pilots have super egos. That is why we are here. We want to be in front of a crowd. We want to show what we can do. And you can say all you want about everything else, but the fact is we want to be in front of a crowd. And so that sets the personality a little bit, right there.

Debbie Gary

It takes strong self-confidence and a sense of self-worth to per-



form safely with style and flair. But it also takes some kind of self-policing to keep our air show egos from puffing up to the point where they blind us and impair our connection to reality.

Deep under everything, we need humility, because this business throws us out there where people praise us, interview us, write about us, and pay way too much attention to us, sometimes. Over time, there is a natural arc, where almost every performer gets an exaggerated opinion of himself or herself. It's a job hazard. But, if you are lucky, some totally humiliating, humbling experience brings you back down to earth and reality.

It helps to have some kind of regulating, self-alert system. Mine used to be landing the Pitts at the end of a show. Since it took total concentration to grease that plane on, I could tell by little hops, skips and jumps when I was flying high on my ego instead of staying centered and focused on my landing.

Patty Wagstaff

You have to be humble and you have to listen to other people. The biggest thing is the Dunning Krueger effect, which states that the more you know the less competent you think you are, because you know there is so much you don't know. The less you know, the more you think you know because you don't know what you don't know. In air shows, there is so much you don't know without experience. There is no shortcut. That is the bottom line. There is no short cut.

It takes years and years. A lot of people think there are shortcuts. I heard someone complaining because they weren't booking any shows after they had put several years into training and had bought a top level airplane, but there is so much to it. I remember Mike Goulian and I saying, "It took us years to get where we are. We didn't just come out of the box and all of a sudden we were booking shows." Where did they get this idea? There is a reason people aren't yet hiring them. The smart air show event organizer wants experienced performers.

6 PERFORMER SAFETY

Every time I have screwed up, come really close to another airplane, or have done something dumb, it was always over-confidence.

What Bob Hoover really made me realize is that, to be great in this business, you have to be very smart. You have to be smart to be a great athlete in anything you do. And, to survive a very dangerous, risky business, you have to be lucky, too. Bob survived a lot of accidents because he was smart. He thought about things. He was able to integrate what he learned.

My dad told me, "Listen to everybody. You may think they are a jerk, you may not like them, but – when it comes to flying – you've got to listen to everybody." You don't want to reinvent the wheel.

You can't just read one book and digest everything. You have to read every book that is out there. I had to read everything, because there might be some little clue in every one. To me, that is the intelligent way to do it. I always felt like there might be one little crumb of information that you didn't understand that would pop back up later. You might not get it when you first read it, but – when the time comes and you are in an emergency and your mind is working differently – it might pop up.

Another essential skill is compartmentalizing, putting things out of your mind and just focusing on your flight. One time, when a friend was going through a personal issue, divorce and stuff, I asked him, "Are you sure you are okay to be doing this show?" He seemed really distraught. But he said, "Yeah, I have so much experience compartmentalizing in the military, from being in Vietnam and so on, that I feel I am really good at it, and I feel very safe." I thought that was interesting.

We can learn so much from military flying because they have such a great safety record, something they didn't always have. They had lots of crashes in the early days, the wars and all that. But since then, they have a stellar safety record for what they do. I mean, the training, fighting, all the kinds of missions they do.



They have a fantastic safety record. And a big part of that is compartmentalization.

Bud Granley

Before you take off or land, you have to stop and look around and tell yourself, “Don’t do anything stupid.” If you are full of yourself, you have to be really careful, because something bad is going to happen.

But what do you do when you see somebody else doing something stupid? You try to be kind about it, and you go up to them [politely and carefully]. And if that doesn’t work, you have to raise a red flag. There is a process, good manners, where you start with the Buddy System, “Are you sure that is safe?”

I asked one fellow, “My God, you recovered from that spin so low. It must recover awesomely because it recovered at 200, 300 feet. And that is not a problem if the airplane just comes right out.” He said, “Oh, no, it takes two or three turns to come out.”

I said, “Then you better quit doing that or move the recovery up.” He said, “Oh, no, it’s fine. It always comes out.”

“You better not do that. You better move it up.” So I got everybody watching him. We all said, “Move it up.” But he wouldn’t. You couldn’t get his attention. He was going to do it anyway. And guess what happened to him? He spun in.

Bill Stein

Early on, flying aerobatics, in particular, I decided not to try and hide my mistakes, because a lot of the guys I knew would make big mistakes and try to hide them. I’d just watch them suffer through trying to keep people from figuring it out. I just decided: Okay, I’m just going to tell people about it. Nick [Nilmeyer] and I were out there every day watching each other and learning together and we learned from our mistakes as much as from our successes. And so sharing mistakes was obviously a good thing

for everybody. I decided that I am not going to be embarrassed by my mistakes. I’m just going to own them and wear them. Sharing all of those hard lessons learned has turned out to be one of the best training tools that I have when mentoring a newcomer into the industry.

When people come to me for an evaluation, I ask them if they are motivated by the adoration of the crowds or by internal things. “I don’t know. What do you mean? How do I tell?” I go, “Do you have just as much fun when you practice as you do when you fly an air show?” If they say yes, then they are probably for real and if they say no, then I think, “Great, this is somebody that I am going to worry about.” If people are motivated externally, they are going to show off, they might have bad situational awareness, they are going to have occasional judgment issues, and you’ve got to talk to them about the dangers of being show-offs.

It seems like all of the great performers have developed the same set of priorities when they are at an air show: 1 - Stay alive; 2 - Keep your license; 3 - Get rehired; 4- Have fun; 5 - Impress the other pilots. It is really easy to get those out of order sometimes, especially when you are trying hard to please the people who hired you for the weekend.

There should be some sort of credentials. Pilots should show up with a history of how they learned aerobatics, what their training program has been like, and what they think they know. And some reasonably good self-analysis of what level of skill they currently possess. It is very important to have an accurate gauge of your own skill level so you can do a good job of risk-analysis, especially when the margin for error is so low.

I tell people, “If you get an ACE evaluation completed successfully, that means that you can go fly a show tomorrow.” If you are just some guy and you have a s#*t hot Extra, or something, and you want an ACE evaluation and you want to be an air show pilot and you’ve never competed or you are just starting to fly [in the] Sportsman [category of aerobatic competition], I might not be your guy because it would be hard to believe in you yet. A lot of these procedures need to be learned somewhere and that is one of the things that contests are great for. So I talk to a guy like that about if they are really ready to fly shows right now, and maybe let’s do a training program for them. It isn’t that they won’t ever be ready, it is just that they haven’t yet built up all of the experience and skills that are needed to safely perform at air shows.

Lee Lauderback

Nobody can argue the point that this is a life or death business. It is not netting butterflies. This is about extreme performance and the end result is, that if it isn’t right, you can lose your life, kill other people or both.

When a pilot comes for an initial ACE evaluation, one of the questions I will ask is, "Where did you do your training?" I feel that people like Michael Goulian and his aerobatic school, Tucker, his school, Greg Koontz, provide excellent entry level instruction. Those are the ways people should start instead of going out there and saying, "Somebody showed me how to do a loop and now I'm an air show guy. I can do a loop low to the ground." I think that is totally wrong. Or, they say, "Well, I trained myself." Okay, we are already sort of on thin ice on that one.

Motivation is important, but I think the training is absolutely essential and I think that is what we need to get into the people coming into this business. There are many ways to do it, but it takes time. It is not just going to an aerobatic school for a week and then you are ready to be an air show pilot. You can't learn to be an air show pilot in a week.

If you come to me and say, "I want to be an air show pilot in the P-51," I'd say, "Okay, come and go through the check-out program.

Then I want you to go get 250 hours in that airplane, then come back and talk to me about it."

I don't sit in the back of an airplane and teach low level aerobatics. There just isn't room for a training-and-correction kind of thing. I'll go up and set a hard deck at 3,000 feet and I'll work with you all day long on a level roll, or whatever. But low to the ground: it is very final.

SEQUENCE DESIGN

Debbie Gary

Good sequence design is the lifeblood of your air show. How you arrange it, practice it and perform it affects your safety, the crowd's safety, plus the quality and tone of the whole air show event. Good sequence design is all about energy management, entertainment values, working with the wind, maneuver displacements, and presentation to the crowd.

Design and perform your sequence so it flows without ever being rushed. Use speed and altitude to keep energy in reserve. Plan your maneuver flow so you recover the energy you lose. Make sure you have a plan for escaping and recovering from blown maneuvers without endangering anyone on the ground. The crowd should never be in danger from your flying.

Planning a good routine involves a series of steps. Learning to fly it well and consistently involves practice, critiquing and work.

Patty Wagstaff

First of all, there are some basic rules and there are no shortcuts. You start with the basics and build on them. Real good air show pi-

lots know the basics and understand energy management. You've got to know the basics.

Every single maneuver needs to be designed and flown with the wind in mind, even something as simple as loops. You want to start your loops downwind so that the top of them goes back into the wind so you can float and you've got lots of room there to build altitude at the top, if you need it.

You can't do snap rolls on steep angles going down because you lose sight of the horizon. You need to shallow your rolls and snaps going downhill. Don't do anything down low that you know you can't duplicate every time, plus a million times in a row.

What I do, when I help people develop a routine, is work out something very, very simple, then build on it. Start with a very simple routine, no matter how accomplished you are, or how capable you are. Then you can add to it as you get better. It is all about energy management and how one maneuver flows to the next.

I worked with a guy who is an 800 foot card holder and he kept asking about adding stuff to the routine. I said, "Let's get back to square one, first. Work on a very basic routine, then you can add. You can always change that turnaround into a whifferdill, or you can turn that vertical into a tumble. But first you've got to have a very basic routine, no matter what level you are."

But, if you change one hammerhead or one looping maneuver, the whole routine changes. Think about maneuvers into the wind, maneuvers downwind. You have to have all-round, good energy management. Then you can build on it to any place, low level and hard core as you want.

You want it to flow, and a lot depends on your airplane and the density altitude. But I think that even some of the really good people don't have a very good routine because they take too many breaks.

I don't know about other pilots, but I love to watch people fly. I watch everybody a lot. When I was in competition, I watched everybody. Other people would hole up in their cars. "Aren't you going to watch?" They were like, "No, no, I'm too nervous to watch."

I always have a plan, like snapping the right way. If you snap left, you are going to displace left. If you snap right, you are going to displace right. You've got to think about that all the time. Is there an on-crowd wind or an off-crowd wind? If I do an avalanche with three left snaps on top of a loop, I know I am going to displace left, so, if I have an on-crowd wind, I have to crab a lot into the wind to give myself plenty of room.

Think about presentation. Keep everything in front of the crowd. Sometimes, you see people who are not thinking about the wind. They do a couple maneuvers, then, next thing you know, they are

in the next county. There is always going to be some wind. You have to build for that.

You've got to watch other people. You've got to watch everybody. Go to other air shows when you are not flying. See what other people are doing. Where are their mistakes? Where are they boring? Where are they losing the crowd? Where are they good? You have to think about all that and you have to get your flying critiqued.

You've got to watch people from outside your own arena. I get on YouTube and look at people from Europe, like Peter Besenyei. He is Hungarian and he is one of my favorites. He does a great routine. He is very, very creative and different. His show is right in front of the crowd and always has something unexpected in it.

Sometimes, people get into a niche. They have their routine and they have their narration recorded. It works for them, but it doesn't mean that it is a great routine and they get sort of stuck with it.

You've got to be humble and you've got to listen to everybody. You've got to look at everybody, even people that you don't like. You can't just look at or listen to one person. And you should know the history of air shows. You learn from the history, from how other people messed up, from the types of maneuvers they did and why they did them. And know that nothing that you do is new, probably. It has all been done before. If you think you are doing a show that is revolutionary, it is probably not.

To me, it is a never-ending process, never-ending tweaking. I'm no longer where I was twenty years ago, and – in ten years – I will be better than I am now, because I will know more. There is no short-cut. That is the bottom line."

Bill Stein

You want your sequence to be safe, primarily, and entertaining, secondarily. What is the entertainment value of what you have going? You have nine hammerheads. That is boring. How did you put your sequence together? One answer should be, "I wrote down all the cool maneuvers that I wanted to do. I put them together in the most energy-friendly way that I could, and then moved them around so that I made all my minimum altitudes."

Another important thing to understand is handling blown maneuvers. If you blow it, you blow it, but people are so bad at that. They don't deal with it. They don't fly every air show like a practice. Most people would rather die than be embarrassed. So when stuff starts going wrong, they get flustered. My solution is: Fly every practice like an air show and every air show like a practice.

I practiced at Wayne Handley's crop duster strip, which is out in the middle of nowhere. If one car stopped on the side of the road to watch, then we had an air show. Each car counted as 10,000 spectators. Afterward, we would ask each other, "Did you have

any people watching you?" Oh yeah, 30,000. And that was really important towards developing the right mindset.

When I practice, and stuff goes wrong, I deal with it. If I blow it, I blow it. If I break off, I break off; it doesn't bother me. If I make a big mistake, the last thing I am going to do is to be embarrassed.

And I don't try harder because there is a crowd. At a big show like Chicago, there might be a million people. So you look down and go, "Holy cow!" Then you go, "Okay, smoke on," and there is no more crowd. There is just the line and there is me. And the best thing I can possibly do to be entertaining for those people is to execute my flight exactly like I do when I practice it every day. And practice it like I am doing the very best I can."

Wayne Handley

What is rule number one in air show flying? You can always leave it out, but you never add one in. I had a good experience with that.

We were doing a show in Truckee, which is a little higher than Reno.

So I came zipping in there, but I didn't get my minimum numbers as I pulled up to do my tailslide. The hair stood up on the back of my neck. I got the creepies. So I broke it off at about a 60 degree climb angle and eliminated the maneuver. Just did a crop duster wingover. Turned around and came back and nobody missed it. Nobody gave a damn. They had probably seen four tail slides already and mine wasn't going to be the best because I was going to be scared.

Energy toward the crowd: I spend a good amount of time talking about energy toward the crowd, so there's no misunderstanding there. I use the barrel roll as example and I draw it out, "Here's the show line that you are flying on. Here's the crowd in this box over here. You do a barrel roll toward them, if your nose doesn't intersect that line going into the crowd area, it is legal. But, if it touches, you are not. So, do the barrel roll the other way."

Maneuver entry speeds and altitude: they are the holy grail. If you don't have them, you don't do it. It's just a discipline, a maturity. Many a time I've not done a maneuver because I didn't have the numbers. And you know how I react to that? I smile and pat myself on the back and say, "You're a good boy today. You done good."

During an evaluation, I'll see a tumbling gyroscopic, lomcevak-type of maneuver and I always talk to them about their numbers, "What is your minimum altitude here? What is your minimum air-speed?" And I'll see this lomcevak in there that I think is too dammed low and I'll say, "What is the minimum altitude? Basically, you are going to go up and do an inverted flat spin. What is the minimum altitude that you would initiate recovery from an inverted flat spin?" And it is going to be no lower than 1,500 feet for

anyone who goes out and does those. It is going to be between 2,000 and 1,500 feet. But I see that they've got this maneuver in there that could very well develop into an inverted flat spin and they are doing it at 600 or 700 feet.

So I say, "Okay, think about this: if you would not intentionally continue an inverted flat spin down below 1,500 feet, why would you pull the trigger on this maneuver at 1,000 feet?"

When I was doing shows, I started my routine with an inverted flat spin and I'd do 30 plus turns. I'd initiate recovery at 2,000 feet because my next maneuver was going to be a tumble. And I would recover from the inverted flat spin by 1,200 feet, have my speed at 1,200 feet and all, then pull up and tumble the airplane at a safe, high altitude. Okay, now the audience has seen that I can do a tumble. Check that box off. Then I would work my routine on down. Then I would end up working my aerobatic routine where I was a crop duster and the ribbon was a power line and so even though I did all the technically dangerous, difficult maneuvers between 500 and 1,200 feet, the fact that I ended up at the last three or four minutes down playing with the ribbon, nobody remembered it as a high show at all. But all my maneuvers that could go sour, they all had a good safety margin underneath them.

When I look at a sequence, I look for stuff like that. A sequence is a work in progress. I'd finish up the season and start with the same routine the next year and I'd say, "Yeah, I'd really like to have more energy here and I don't need that much back here, so let's switch these two end-box maneuvers to where I've got more smash down here." So I was always tweaking it a little bit.

Energy-losing maneuvers: my philosophy has always been that I wanted to grab the audience with my first maneuver, bang, bang, bang, bang, and never let go of them. I just wanted to keep it going. Whereas, some people will do an interruption, a break and climb and talk over the mike, then start all over again. That is just personal preference. That is their way to manage energy-losing maneuvers.

Sequence interruption: it is not competition aerobatics. Don't worry about it, especially if you have got some way to keep the announcer on the same page with you. I would start all the performances with the audience on my left, but there was a wind consideration when I did the torque roll. Then I could leave the torque roll going the direction I needed to, do a turnaround maneuver, then that next maneuver I needed a lot of smash and the way it translated sideways, I wanted it going into the wind. So I just had that direction option in that part of my sequence. So that is how I handled that.

But, sequence interruption, say the air boss calls you and stops you, or whatever. Take advantage of it. Get your altitude. Get your airspeed. Take advantage of it.

David Martin

It helps a lot to have someone that is a mentor to help you with sequence design, because it depends on the airplane, too. Sometimes you think, "Oh, that is a great sequence design." And somebody watches it from the ground and they say, "No, it isn't." Then, of course, there is safety, too. There are things that a young person new to competition or air shows would not think about that an experienced person will say, "Hey, that is kind of putting yourself in a corner."

I know this is kind of a controversial topic, but some of the old guys told me never to do reverse Cuban eights. Jim Roberts was like, "Never do that." Then we had that whole thing with the Air Force guy talking about Split S's. He was saying that, if you do them right and you plan for them, there is no problem, which is probably true. But I mean, why do them? If you can do a half Cuban eight, why do them? It's a good place to screw up.

And you don't have a lot of options. Once you do a Split S, once you start down, what else are you going to do? You're not going to roll out and push. I would leave them out, especially starting out. In a real high performance airplane, I still don't ever do them. But I was watching an air show yesterday with a reverse Cuban eight and it doesn't look very good. Why do it? Nobody is ever going to say, "Wow, he had a great reverse Cuban eight."

Bob Bishop

A sequence design should allow for energy recovery. Some people come up with a routine that is on the limits of what the plane can do performance-wise. And they are not getting enough time in between maneuvers, or are not designing the maneuvers in such a way that there are recovery maneuvers. In other words, they might have a fast maneuver that leads into an overhead where they use up that energy. You don't do a high speed maneuver, then slow up, do a snap roll, then go back to high speed again. Make it flow.

I look at a routine and ask people, "What are your numbers on top? For any overhead maneuver, what are your numbers?" Some people look at me like, "What are you talking about?" I want to know the altitude and speed range for a maneuver like a loop, or any overhead maneuver. What are the numbers? Because, you can actually have too much speed on top.

If you don't recognize it, and start pulling through, just by rote, and I'm talking about a jet-type airplane, and you have an extra 30 knots on top of what you normally have, if you don't recognize it and don't start reefing it in pretty quick and put the Gs to it while you are slower, your radius is going to increase way out there. So you've got to know the numbers on top and you've got to look for them.

Well, this guy who hit the ground in a MiG, he forgot and left his flaps down, okay? The numbers at the bottom weren't sufficient. He had a drag configuration. He never looked at the numbers on the top. So, before you commit yourself to a pull through, know the numbers and make sure you've got them, and always design your routine and those overhead maneuvers, with at least a 25% safety factor.

My minimum overheads for the BD-5 jet were 2,000 feet AGL and a speed range between 60 and 100 knots. I knew I could just get it around in 1,500 feet. I could get it done, but – with 2,000 feet – I could let it out at the bottom and lighten up the Gs. I could come close to the ground and have it under control just buzzing the runway. It's not the same thing as having to pull hard just to miss the ground.

Next thing I look for in somebody's routine is if they are getting in a rush. This is a problem in front of a crowd. There is some psychology where they just can't stand to be embarrassed. And the tendency is, when you don't do a maneuver quite right, you don't take the time to really recover and set up the next maneuver. Instead, you just go right into it. Then, one mistake leads to another.

So, I look for people who know how to design a routine and, particularly when they are starting, then fly the routine so that they give themselves the mental time to kind of set up the next maneuver before going right into it. As you get more experienced, you can make it flow from one to the other to the other.

Also, don't let yourself get rushed by changes to the air show schedule. Don't let the air boss say, "I need you in there right now," and tempt you to get in a hurry. I've seen accidents where people rushed. They forget things. They panic. One pilot forgot to close their canopy and when it opened in flight, which is not actually a big problem, they panicked and pancaked the plane onto the runway. With the right mental attitude, it would have been okay. The canopy is open. That is okay. I'll just go down, shut it and come back up. Unfortunately, they got flustered and wrecked the airplane.

Another thing is: no energy toward the crowd. Do not endanger other people. It doesn't take a mental giant to see that if this airplane comes apart at this point, that it is going into the crowd.

Also, no "approval suck" maneuvers. Those happen when the person is so into getting approval that they are doing maneuvers that are beyond themselves and the capabilities of the planes. A lot of time these are done to impress their peers. They are not safe.

Entertainment-wise, make sure you have a well-planned, well-thought out routine from the time the stage is yours until the time you are off it. Don't have dead time. If you are going to get the stage with a ground start, have a music background. Have something going on that people understand is part of the routine. Have

a way to focus the attention where you want it.

And timing is everything. Air shows need to understand this. You can't get sloppy, because you set the tone. You can kill off the energy by having little dead spots. If you want to have a really good show, you've got to start it out right. If you don't get started right, you are going to have a hard time getting it to flow together.

I used to do part of my routine to music and there was a section of that which was just a wonderful kind of up, up, up sound, followed by crescendos. Then it segued into something else. I found that, if I could put my tailslide exactly where the music hit the crescendo, people would be crying. If I missed it by five seconds, it was not the same.

Bob Carlton

In a glider, there are a few things that are important to choreography. The first is that, early in the sequence, you need to have some simple maneuvers that are easy to do and that allow you to ascertain whether the air you are in is rising or descending and will give you an opportunity to fix a bad position if you've started in a wrong position.

For example, I start with four clover leaves on 45 degree angles because those are nice, simple maneuvers and by stretching any one of them I can move myself upwind, downwind, or crosswind if I don't start in a good position, or if there is less wind than I expected. And, at the end of those, I should lose exactly 500 feet. If I lose more, I know I am in descending air. If I lose less, I am probably in rising air. So, in the first minute, I have figured out the wind effects and if the air is rising or descending.

I learned that, because I started in gliders, and – at the first two or three shows – I found myself a mile downwind wondering if I was going to get back to the airport.

I tend to do rolling maneuvers into the wind and looping maneuvers downwind because that allows the routine to naturally track into the wind. And I try to end one maneuver at the entry speed of the next one.

I do something that starts with a slow speed and ends with a high speed, like my horizontal eight. I come in, basically at landing speed, and push the engine to full throttle, and then turn away from the crowd. [Note: Carlton flies a Salto sailplane outfitted with a military-grade 225 pound thrust jet engine.] It has a couple effects. One, it looked like I was going to land and here I punch things up right off, pointed away from the crowd for the maximum sound effect. That is when I flip on the engine smoke and go from landing speed to redline as I do a horizontal eight. It sort of shows off how much power this little engine has. Then I can pull up for a vertical.

That is the first time I do anything much above idle in the whole routine. You can go from landing speed to redline and – while you are doing that, with those big glider wings flexing – it’s a great magic trick ... something that looks hard, but is real easy.

From the crowd’s perspective, it should look like you are doing the impossible. But from the cockpit, it should be so easy that you can do it at 10,000 foot density altitude, when you drove until 3:00 in the morning to get there, and had a problem with your plane that morning, and your wife called to say that water is bubbling up from the front yard, and the air boss is screaming over the radio at the war bird that comes on after you because he is late.

So, don’t choreograph a show to the extent of your capabilities on a good day. Choreograph a show to your capabilities on your worst day.

Greg Shelton

If you don’t have an out in your air show routine, if you are pulling hard to clear the ground and stuff like that, you are not going to last very long. You always need one out, preferably two or three. That can be done with extra altitude, roll rate and available G.

If you are doing a barrel roll in a T-6 with a slow roll rate and you get to the apex of the maneuver and have not rolled to the 180 level before you start down the back side and you’ve got to roll some more before you are inverted, you are in serious trouble.

Don’t do snap rolls or tumble type maneuvers on a 45 degree down line; a lot of people get killed doing those. I think it has to do with the high roll rate and your depth perception. Maybe they don’t realize they are starting to arc, that the plane is no longer holding straight. They are losing a great amount of altitude and they don’t realize it.

Hammerheads with snap rolls on the vertical down line: when you’re flying down the show line, put the crowd to your left, so when you come up, you pivot toward the crowd then do your snap roll going down. When you first snap it, the lift vector is pointed toward the crowd. But when you get one half or three quarters of the way through that snap and realize you are in trouble, you can now stop your snap roll and pull out away from the crowd.

In the Stearman, I do a hammerhead with a snap on the down line with Ashley on the wing. Instead of doing the whole 360 degree snap, I stop, maybe 30 degrees early, so that puts me on that line away from the crowd. If I were to go ahead and stop on the line, parallel to the crowd, I would have to make a left turn as I’m pulling my nose up and that is going to cost me energy. So, I stop it a little early, and that puts me straight on the heading that I want for my wingover turnaround. So, it is one less turn that I am putting on it as far as induced drag. When you have a wing walker, every little bit of energy is life. Speed is life.

TURN PERFORMANCE, CORNERING VELOCITY AND ENERGY MANAGEMENT

Lee Lauderback

Aerodynamics, as it relates to high performance maneuvering, is especially important. There is no question about it. In the war-birds, you are flying high performance military airplanes that are not certified. They are not designed for the average Cessna pilot. They are designed as military war fighting machines.

So, aerodynamics and turn performance have even more significance than in flying a Decathlon, for example, or a Pitts. You are working in the same basic altitude spectrum: 250 feet is 250 feet.

And yet, 250 feet in a jet going 500 knots is different from 250 feet in a Decathlon or an Extra. Things just happen faster.

Strong, basic aerodynamics aren’t really addressed in the normal certification process. So, when you take your commercial flight test, cornering velocity is not an issue. You have to go in [on your own] and sort of get that and learn it and understand how it applies to your airplane.

We all talk about the reverse Cuban eight in a high performance airplane. It’s a good reversal or turnaround tool. Once the airplane is in the vertical or near vertical, you are totally committed. So, how does somebody learn to do that? You don’t just go up and say, “Well, here are my charts and here are my graphs. Now, at 1800 feet above the ground, I am going to roll and I am going to pull and it is going to work out fine.”

You’ve got to start up at 5,000 feet and say, “Okay, it is 5,000 feet density altitude. What does it take? How can I do that?” And, in my world, I’ve got my numbers, not just because I calculated my numbers, but because I went up and proved my numbers, in my style of flying and in my airplane. Then I pad those numbers, and from that pad, I put an additional pad.

I never pull to the buffet. But, if I have to pull to the tickle of the buffet for max coefficient of lift, I now have flaps available, which will make a substantial difference in the rate and radius of the airplane. So I’ve got two safety margins built in. But that was all determined by going up and doing it and practicing it under all conditions. So, you cannot do this by getting into a graph in the P-51, and then bring it down and expect it to work well. The calculations are a guideline. They are not the bible.

When the ground is approaching, are you looking at your altimeter or looking at the ground? You are looking at the ground. How do you learn to do that? It comes with years of experience and seeing it in less critical areas. That is, starting someone at 800 feet, then 500, 250, whatever. I just think that, in a lot of senses, the in-



coming air show guys are too impatient to get where they are trying to go.

Another question is, “What is the stall speed of your plane?” 70 knots? Great, but at what G? Because you can stall a plane at any speed. If someone comes back to me and says, “It is the square root of the load times the one G stall speed,” they are already out on the far end of the knowledge base.

This stuff is essential for warbird training because these planes have no stall warnings, bells, buzzers, beepers, whistles, shakers, pushers, pullers, all those things that are on normal airplanes.

I went up and looped a Mustang with a guy. We went up and set a bench line altitude of 10,000 feet and we entered the loop at 260, then we entered the loop at 250, then 240 and kept taking down a point over and over again. Even though I could calculate that if I sat down with a super computer, it is incredible what I learned just by going up and doing 40 loops in an hour and a half, all being documented. Then we came down and put the data on the board.

“Okay, what are we looking at here? Wow, there is a learning curve.” And it pretty much supported the formulas and things. But it was a wakeup call even for me. This stuff is pretty interesting. But does the average person go up there and look at that?

Dale Snodgrass

Cornering speed is an important number for fighter pilots. Basically, it is an indicated airspeed in which you have knots sustained turn rate. At a given airspeed and a maximum thrust, you can sustain your best G loads. It is not necessarily your best turn radius, but it is your best sustained turn radius. It is all about sustained energy, not instantaneous energy.

Instantaneous turn rate is based on just putting the stick in your lap, essentially, and generating as much nose movement as possible. But when you do that, you are obviously going to lose energy. Your airspeed is going to diminish. So cornering speed is an airspeed in which you can sustain your turn rate, which means degrees per second.

In high thrust to weight airplanes, fighters and stuff, we use cornering speed to compare airplanes. We use that as a tool to fight other airplanes, because – given a wing, and thrust to weight ratio – the cornering velocity of airplanes may vary significantly. Like for instance, in a MiG 21, the best cornering velocity is like 450 knots. In an F-14, it is 325 knots. In an F-18, it’s about 385 knots. In an F-16, it’s 425. So, that is where a combination of thrust and wing loading meet for a best sustained turn rate.

But, in the air show business, it is a number which is lost on a lot of people, because — in the majority of planes we have — the cornering velocity is semi-immaterial. The airplanes don’t have the thrust to weight to sustain the turns. Or it is so low that it doesn’t really matter. In other words, if you are in a Decathlon, your best sustained turn rate is probably at 110 knots. But your G loading at that speed would probably be less than 2 Gs. So everything is sort of instantaneous Gs. It is kind of weird, because, down low, airplanes like a Pitts – or even an Extra – turn so well at slow speeds that it is not as critical a term as it is for a guy flying a more high performance fighter-type airplane.

Obviously, there are air show airplanes out there with high thrust to weight values, but – at the same time – their turn radiuses can be very low. It’s not a big factor unless you are flying a P-51 or a war bird or something like that. Then it is a little more applicable. But, even in those airplanes, the thrust to weight is so low that the G loading at sustained turn rate is at whatever speed the plane turns the best.

The best would be, if you are at full power, what is your best airspeed to complete a split S? That is probably a more applicable number.

If I was setting it up in a low energy airplane, which is pretty much everything on the air show circuit, what is my minimum altitude to execute a Split S?

I’m transitioning from this to something that is more applicable for us. Then that number is driven by very critical things. It’s driven by your entry airspeed. So let’s assume that, if you entered a split S at V_{ne} , your turn radius is going to be a lot more than if you en-

tered at 110 knots and got up to 130 or 140, where the plane does its best turn rate. Cornering velocity is the airspeed at which a plane turns the best, and you are using gravity to help you do that. In other words, if you are doing a nose-low turn or even a split S, then it would be nice to know what that number is. And is that a full power event or a partial power or an idle event?

The problem is that, in a lot of these airplanes, the manufacturer doesn't generate those kinds of numbers, like they do in a fighter, obviously. You don't get a tactical manual with your Marchetti or your Extra 300, where you have piece of S equals zero, and all your massive amounts of energy management graphs. In a fighter, you have massive documents a couple inches thick with all that information that you pore over and absorb and apply when you operate the airplane tactically. They tell you exactly how your aircraft functions with airspeed and G in various configurations at various altitudes and thrust levels, whether you have drop tanks on, how many bombs and so on. But, in our case, in these airplanes, that information isn't readily available.

The T-6 didn't have that and the L-39 doesn't really have it, and the Sabre, and the older jets didn't have it, either. It sort of came on later. So, I basically went up to altitude; I knew I could get to 10,000 feet in an F-86 and 5,000 feet in a T-6. Then, at a couple different airspeeds, I would do full power and idle-power split Ss and said, "Okay, I know exactly what my mins are now."

When you get into your performance and are practicing down low, then you cross check your numbers both on the entry of a maneuver and at the top. So you know you have the correct energy package to execute the maneuver, then you cross check your altitude and airspeed at the top, so you always know you have an out.

So, for instance, if I'm in my F-86 and I'm coming over the top... maybe I am at 2,400 feet, because I'm trying to push it because of clouds, or something. I've got an undercast or an overcast I'm trying to squeeze below and I end up at 2,400 feet. I know that I'm not going to make it. It is too close. Then I execute a half Cuban kind of thing or I come out nose low, oblique away from the crowd or something to make sure I have the turning room to miss the ground.

And that is something in cornering velocity that goes back to another fighter term that is called turning room. So, what does that mean? I have the turning room in the vertical to make sure I can get through a vertical maneuver and recover above the ground.

There are a couple classic cases of not having enough turning room. These were jet guys. One was a guy in an F-86 (June 1, 1997, Broomfield, Colorado). He decides to do a reverse Cuban.

He enters real fast. He is going like 500 plus knots. He pulls up. He goes to like 3,000 feet. But he is still going 350 knots and he

commits nose low to do the reverse Cuban, which — once he rolls inverted and pulls — now it is a split S, by definition. And his energy state is so high that his turn radius/turning room is so big that it doesn't meet his altitude requirement. Once you get the nose committed 90 down, you're in a total commitment event and there is no option. So all you can do is pull, and he is going so fast that his turning radius is so big that that he didn't have the turning room to recover, so he kills himself.

Same thing with both the Thunderbird (September 14, 2003, Mountain Home AFB, Idaho) and another F-16 demo guy (March 19, 2000, NAS Kingsville, Texas) doing an exact similar thing, a reverse Cuban and didn't have enough altitude to pull through. They don't have enough turning room and they hit the ground. So, turning room for all of us is very critical. We all instinctively know about it, particularly those of us who have been around. But I'm not sure how many people actually figure out what it takes to do a Split S, and how airspeed and power impact that Split S.

If I'm full power in an AT-6 and I'm at 180 knots and I do a split S, what is my turn radius, versus if I'm at 110 knots and at idle power as I come down? That magic airspeed, that original corner number, corner velocity, varies. It is hard to determine with little airplanes, it's sort of a wider band in most cases. But, if I'm in an F-14 or I'm in my MiG 17, if I'm at the top pulling through and I wind up at 350 knots, for whatever reason, I'd be at idle and boards on that pull. If I were at 150 knots, I'm better off being in full power, because I'm adding energy to the airplane and keeping the airplane closer to where it turns the best.

So, it is just a function of trying to figure out those numbers that work for your airplane, then you cushion in that with everything. So that in my flying, I actually fly very low, but if I'm coming out of a loop or a reverse Cuban or a split S or something, the last 600, 700, 800 feet, I would try and feather it. It's not a maximum turn radius event. You are already through. You could be through the maneuver at, at least, 1,000 feet. In a jet, it might be 1,000 feet above the ground. The last 800 feet or so, you are just driving it toward the ground. You are feathering it down there. In other words, you are driving it to a point. You're not having to pull hard just to finish the loop.

For instance, I can loop the T-33 in 2,600 feet, if I do everything right. But when I normally do the loop, I want to see like 3,500 feet or even 4,000 feet at the top. Then I can float it over the back side and pull the power. I can manage my airspeed properly. Then at the end, I am feathering it down, reducing the pull so I am finishing at show center at 30 feet.

I'm just reducing the G and bringing it in so the bottom of the loop is very, very controlled and very benign. It's not a five G, six G pull that is terminating at 30 feet. I'm coming from three to four to five Gs to three Gs to two Gs to a one G pull out.

I'm not a big aerodynamicist or a test-pilot kind of guy, but I think the biggest thing that people need to do is they have to know what their minimum turning room is. And turning room is the minimum altitude you need to execute the maneuver, so that you recover without hitting the ground. You need to know what the turning room of your airplane is. So, as opposed to doing lots of reverse Cubans and stuff, I teach war bird guys that — when they finish a maneuver — to then turn 30 to 45 degrees off the show line, away from the crowd. Then go vertical again and turn back in.

Ninety percent of them do that. What that does is, as your energy depletes, it allows you to still have the turning room to come back, because now you are not using your turning room. You need extra turning room to come back. But now you are using the oblique, as opposed to the pure vertical, which gives you more time. You can extend your radius and gain energy. So it increases your turning room and you can come back in the oblique. Say you go to the left corner. You see in all the fighters, the guys all go out to the corners, then they turn back in to get on the show line. Well, that is to make sure they have the correct amount of turning room, which allows them to regain their energy for the next maneuver.

I always ask guys, “What is your airspeed at the vertical?” Maneuvering in the kind of airplanes I fly, the critical event is your entry airspeed. What is your energy package when you pull and then how do you pull? If you fly the profile with the right energy at the bottom, I guarantee you that, at the top, you're going to have the right energy and more than enough room to come back downhill. So, the energy package is what is critical.

Now, if you are in crazy airplanes that are super light and have super thrust to weight ratios, like Sean Tucker's airplane or some of those airplanes, they sort of defy everything we are talking about here. There are only a few of those guys and, most of the time, they practice a lot.

You learn by practice, by what pulling too hard does to your airspeed. You know, coming down the back side, feathering also keeps your speed and keeps your energy, as opposed to pulling things too tight and so on.

Like, for instance, if you are doing a loop, or something, kind of pointing the nose down and get through 5/8ths of it, or 3/5ths of it, you're already through the vertical. You come through and now your nose is somewhere around 45 degrees nose low, so you've gone through most of that turn. You've gotten through 150 degrees or 120 degrees of that turn in the first one third of your altitude loss, or half of your altitude loss. Then the last 45 degrees to get back to wings level, you are using at least half of your altitude or no less than a third of your remaining altitude. So you've gotten your turn. Your turn is executed past vertical, but you still have anywhere from a half to a third of your altitude left.

Ideally, I like to have about a third of my altitude left, so at that point I can come off of the G and now I am just driving to a point down at show center. In my mind, I put a little tiny square in front of me, a little window that I am driving the airplane to. And I want to go through that window wings level, so I am all set up. I am driving through, like a little bridge down there and I want to go under the bridge. But, I don't want to go under the bridge while I'm pulling through. I want to be wings level going down to the water.

Wing loading, how many square feet your wing area is, basically tells you how tight your airplane will turn. It basically gives you how much lift the wing will provide. The ultimate high wing loading airplane on the air show circuit is the F-104, because it simply has no wing. So what does that mean?

Even at high thrust, its turn radius and its turn circles are very large. That is why the Star Fighters never do any overheads, because the wing loading is so high. They just go out and go away for three minutes and then come back. The reason is that the wing loading is so high that it takes a long time to turn the airplane around. In the two-seater version of that airplane, you go to half flaps at 500 knots. And, if you are at 450 knots and you have the flaps up, you pull and you get to two Gs and the airplane is already in buffet and stalling. So that is a classic where you have a very high wing loading. The ultimate light wing loading on the air show circuit is the gliders. They have very low wing loading. That doesn't necessarily mean they can turn tight, because to turn tight you have to have the correct amount of elevator to make that move. So airplanes vary in combinations.

Wing loading is the square footage of your wing versus how much your airplane weighs. So a normal jet fighter like an F-14, F-15 or F-16 has a wing loading of about 80 to 90 pounds per square foot.

Thrust will compensate for high wing loading to a certain extent. The more thrust you have, then the more you can compensate for high wing loading. A Decathlon is very low thrust to weight, but it also has a very low wing loading.

INDUCED DRAG

Debbie Gary

The less drag a plane has on it, the faster it can fly, potentially. The shape of a plane — boxy versus sleek — affects the drag. The things you hang on your airplane — camera mounts, smoke generators, wing walkers — increase the drag. But, for an air show pilot maneuvering close to the ground, where every knot counts, the one kind of drag you care about, every minute, is the one that you feel in your body, when you pull Gs, and control with your hand when you move the stick. It is induced drag.

A tiny release of back pressure to reduce this drag, can get a

stalled plane flying again. Induced drag increases with rough handling and decreases with smooth flying and a sensitive touch. Truly understanding how your hand on the stick controls induced drag can mean the difference between life or death on a pull out.

Wayne Handley

You control induced drag from the cockpit by your drag lever, which is your elevator. An airplane cannot stall if the wing is unloaded, if it has zero Gs on it. How hard you pull the stick is how you control induced drag, so unload that sucker. Just unload it. If you go to zero G, you are not creating any induced drag.

Kirby Chambliss

Skip Stewart and I were doing Tinstix. They weren't blowing up stuff, yet, but we were both in high alpha, hanging on the props, going down the runway together. And, in El Salvador, right on the end of the runway, it drops off into a 250 foot ravine that is basically where two mountains come together. There is no bottom as far as something you can land on, or even a flat surface; it is all jungle.

We were hanging on the prop, maybe had 40 knots, I don't know, but just hanging on the prop. Just moving across the ground with the wingtip probably three or four feet above the ground, just cruising.

Then, just as we went across the end of the runway, my engine went, Whop! Bam! Just stopped. So, from the time it stopped until the time I hit the first tree, if it was ten seconds, I'd be surprised.

I dumped the nose the first time and tried to load the wing. I know the airplane like the back of my hand, but I am usually loading it with power on. So, without power, I tried to load it and it wouldn't load. Dumped it again, got it to load, got the wing loaded again; in other words, I got it flying. Probably had three seconds.

Then, I intentionally hit the left wing on a tree and took two feet off the left wing, then I took two feet off the right wing, then knocked the engine off the front. I got the tail. I got about everything you could. Instead of taking one really big hit, that would have probably croaked me, I took three smaller ones and then got out of the airplane. It was upside down, on the side of the hill, still 15 feet down from the very bottom.

It was all just a jungle of trees and it was pretty steep. The only thing I did was bruise my right arm. So, I was able to crawl out as I had just enough room between the canopy and the ground.

"I was really lucky, I'll tell you. I only had a few seconds to get the airplane flying. Obviously, falling is not good, so to be able to get the airplane to fly...I just had a couple of seconds to do that. I think that is probably what really saved me, just instinct to basi-

cally take over. Boom, nose down, load it, nope, unload, second time load, got it flying, left wing, tree, bang! I had time to say two bad words and think in my mind, "Oooh, this is going to hurt." And that was about it.

You've got to fly the biggest piece down, they say. When you are vertical at 250 feet when it quits, you've got to get the plane flying first, then fly the plane.

Greg Koontz

You can unload the wing a lot more in ground effect with the wheels almost touching the ground and maintain more speed for the next maneuver because you can reduce the induced drag. You can actually accelerate. Just watch yourself closely low to the ground how much you can unload the airplane to stay there. You can watch the airspeed pop up.

Another place you can change induced drag for your benefit is sometimes at the top of maneuvers. I'll use a humpty bump, for instance, to go over the top and actually come out with a little more energy than if I keep using a hammerhead. I can unload the wing completely and float over the top and actually the plane is going to try to accelerate because there is no load on the wing. If you sit there at zero G, you are going to have that angle of attack right at zero and the airplane will accelerate better than if you are pulling hard over and down, which would tighten your radius and keep the wing loaded and decrease the amount of your acceleration. By letting it float, the airplane will make a wider radius and accelerate.

If you watched Bobby Younkin, he used to take off in the Super Decathlon and start from the ground and within about five maneuvers he was doing outside loops. He was building energy with every maneuver and that was the kind of thing he would do constantly. Another thing, I used to always pop the plane in the air around 60 and hold it in ground effect building up speed. But he would roll the wheels with no lift being created with the tail high in the air to accelerate all the way to 100 and I started trying it and you will accelerate to 100 a lot faster. It is quite noticeable, because the friction of the tires with the ground is not near what the induced drag is with the airplane trying to accelerate in the air.

Greg Shelton

I watched a guy in a low performance biplane making climbing turns after his maneuvers that carried him over to the 1,000 foot line. Then, when he dived back in, he would be off-center, so he would have to roll into a turn as he was diving and put G on it, which cost him energy. In a T-6, that will cost you 10 to 15 mph.

So, if you come down the centerline, paralleling the crowd, you always want to turn out first, away from the crowd, pull the nose up, reverse and, when you are at the apex of your turnaround, you are

back on the 500 foot line. So now when you unload and dive in, you are not putting any G on it to make a turn. You are not putting any induced drag on it. Then, the steeper you make it, the less drag you put on it, the faster it is going to go, not only because of gravity, but also because you are unloading the wing more.

Bill Stein

What I try and do is to tell people about every mistake that I've made that is relevant. I try and tell them about all the mistakes that everybody else I know has made, that are relevant. And this one is about really understanding increasing and decreasing induced drag

This mistake was at Salinas. I tell people I love the ACE program because, when I was at 500 foot I made a 250 foot mistake and, when I was at 250 foot I made a 150 foot mistake. I totally botched the thing. I was at Salinas and it was actually a humid day, which is unusual, and it was hot. But I'm at sea level and I'm in my crappy old Pitts and smoke is everywhere and, pretty much, I botched a flip-top maneuver. And I am in this kind of deep stall. I'm just in this buffet and I'm thinking, "What the heck!" And I sit there in this buffet with the stick pulled all the way back sinking at whatever rate a Pitts sinks, for 150 feet before I think, "Oh!" And kind of get myself together and push the stick forward and let the airplane fly, then go.

So that was at an air show that I did that. And I was totally surprised that this happened. It was one of the first times in my aerobatic career that I've been surprised in the box because something that simple went wrong. I was totally out of energy and there was no reason for me to be.

I tell that story to people and that is my very visceral understanding of what Wayne Handley calls the induced drag control lever, which is the elevator.

GROUND EFFECT

John Mohr

I would explain ground effect as the high pressure that is underneath the wing, when you are low to the ground. I can envision it like a pillow, like it starts packing up between the wings and the ground. The closer you get the wings to the ground, the more the pressure builds and the more cushion you get from this pillow.

I can only speak from my experience, because there are not a lot of other people that use ground effect in air shows. I don't know anybody, in modern times, that uses it to the extent that I do in my Stearman. Probably back when they were flying underpowered airplanes in the early days of air shows, in the barnstorming days, in the 20s and 30s, I'm sure they used it. Because, when you are

flying an airplane that is right on the ragged edge, and you need, say, 120 mph for a loop to ensure you come out of the backside without mashing into the ground and enough energy for the next maneuver, 110 versus 120 is huge. A little less than 10%, or it could be 10% in a Stearman. Well, that is a huge number. When you are flying an airplane that is 200 knots or higher, that might not be such a huge number.

All I know is my experience with the Stearman and what it does for me. Then 10% to 15% is huge. It would mean the difference between enough energy to do my next maneuver, and continue to do maneuvers, or to stop and climb.

Some shows I've done, like over in the Middle East, where they don't understand ground effect, and they had people from the UK with rules that said you can't go below 50 feet and you can't do a loop below 300 feet and all those sort of things that they tried to impose on us...well, to me, that meant that I had to start out higher and to continue to lose altitude throughout my maneuvers. So the show that I do, the magic of it, I attribute a lot of that to ground effect. I can see that it really does make the difference between flying the whole series of maneuvers and staying at the same altitude versus starting high and continuing on down as you lose energy.

Ground effect is most pronounced when your wings are level to the ground and you are definitely within half a wingspan or less. In some cases, I am in a shallow turn. I don't want to be in too steep a turn when I am that close to the ground. Obviously, I'd drag a wingtip. I know that when I get it down to where my wheels are just inches off the ground and moving along in that manner, it is more pronounced than when I am even half a wingspan above the ground. It is definitely noticeable. I can pick up that 10 mph, 15 mph by staying right down there.

The other thing that happens with my airplane because it is not constant speed, it is fixed pitch, as I increase airspeed, my RPM increases also and with a round engine which is limited to about 2100 RPM, again, 10%. Another 100 RPM in a round engine, in a 220 Continental, is a huge thing. I not only get the airspeed gain, but I start to get an RPM gain. And, when I start to get that, I develop a little more power. It pulls me a little faster and the whole thing compounds itself for the good. If you stay down there long enough with a nice straight run of, I don't know, several hundred feet or longer, you can tell things happen. You can tell the increase in speed, the increase in the RPM. Even if it is only 50 RPM, it still makes a difference.

I also know from seaplane flying that when you break clear of the water, in many cases, you've reached the maximum planing speed of the hull in a float plane or a flying boat. It gets to a point, sometimes on a high density altitude day or a high altitude lake, with a heavy load where you've reached the maximum planing speed of



the hull before you can get it in the air. In other words, you are just below stall speed. So, if you force it into the air, suck back on the yoke really quick and pop it into the air, it's probably not ready to fly. And if you climb away from the ground any amount you would probably end up stalling and settling back into the ground, or the water, in this case.

By keeping it just inches off the water, you are taking advantage of ground effect and you can actually feel this cushion. You gradually reduce your pitch and the airspeed increases until you finally get your best rate or best angle of climb, then you can start climbing away.

The same thing happens in soft field takeoffs, even in a tricycle gear aircraft, any type of airplane...high wing airplane, it doesn't matter. You can get the airplane off the ground, or out of a muddy field, or what have you, probably at just below stall speed, or what is written in the book as stall speed. So you use this cushion of air to your advantage to get it airborne, reduce the drag, see if you can accelerate to your best climb speed and climb away from there.

There are accounts during World War II of bombers that lost two engines, maybe even three, and they were back over the English Channel heading home and they thought they were going to have to ditch. As they got lower and lower over the water until they got down right above the water, all the sudden the ground effect helped them out and they gained enough lift to continue on and stay in ground effect to continue to where they were going, or at least to get close enough to land, ditch and be rescued.

HIGH DENSITY ALTITUDE

Density altitude (DA) is the height where an airplane thinks it is flying. It increases as temperature, pressure and humidity increase. This increase diminishes the performance of the airplane, the engine and the pilot. It adds complications to air show flying. The air is thin and true airspeeds are higher. Pilots become fatigued and dehydrated more easily. Engines lag. Airplanes gobble up altitude. Everything you do takes more time and more space.

The air show sequence you fly so impeccably and comfortably at sea level needs modifications when you're flying in high density altitude conditions. It needs escape routes. It needs enormous amounts of on-site practice to condition yourself to these hot, high-altitude days.

Michael Goulian

The best piece of advice I ever got in the air show business was in El Paso, Texas in 1995. The Eagles were doing one of their last shows and Gene Soucy came up to me and said, "Hey, have you ever flown a high altitude show." "Nope," I said. "Remember one thing," he said. "Indicated is indicated. If you need 200 knots at sea level, you need 200 knots at 5,000 feet. It takes a lot longer to get there, but indicated is indicated." And that is almost everything you need to know about high DA flying.

It is harder for the airplane. It takes a lot longer to get to whatever speed you need at high DA, and there are all these other idiosyncrasies. You've got to pull less. The airplane is happier tumbling and it stays hooked up more. All kinds of things like that.

If you are really going to do it right, you go to Reno, or wherever, five or six days early, because everything is different. Visually, it is different, especially if you come from the east coast. When you are at 3,000 feet AGL, it looks like you are next to the ground.

When I first practice [in a high DA environment], I just start with a loop, a hammerhead, a loop with a snap roll on top and a roll down. And I pull from the ground into a stall to see: Where is the buffet? Where is the stall?

Another thing people don't know is that the difference between 80 degrees and 90 is like the flick of a switch. You can kind of survive high altitude at less than 80 degrees, but – as soon as it gets to 90 – all of a sudden you go from flying the most amazing aerobatic airplane ever to a Cessna 172. What happened to my airplane?! So, I always listen to the ATIS and get the DA before I take off.

The airplane is happier in a tumble. So, if you normally do two rotations in a tumble, at high density altitude, it will allow you to do three.

The torque roll can kill you because the airplane will stay there. It will back up further and, when it flips ends, you come out down low with zero airspeed. So I don't actually do a torque roll at high DA. Or, if I do, I don't let it slide all the way back.

A lot of these things you don't know until you have a ground coach watching you because, if the airplane is tumbling, it feels like it is climbing when it is sinking a lot. The first one might be climbing, the second one is level and the third one is already coming back downhill. People don't feel that and they don't know it because the nose is still high. So, if somebody is not watching you on the ground or if you haven't watched other people do it, you don't understand it.

I never do snap rolls going down at high DA. I do them in my normal show, but I will take all those out and turn them into aileron rolls. So, it is all about keeping energy.

People think, "Hey, I can do this. I can fly the same show at 5,000 feet that I can at sea level." And they think, "The laws don't apply to me." But the laws apply to everybody! Your ego, that is the biggest thing. You have to put your ego aside. "I want to go to Reno and I want to fly the most crazy, kick-ass air show I've ever flown in my life." Truth is that you can't. It's just the way it is. You could have triple the horsepower and it still wouldn't matter.

Sean Tucker

Over the years, I've figured out that my average air show in the summertime is at a density altitude of 3,000 to 3,800 feet on an 85 degree day with 800 to 1,000 foot elevation. That is my baseline.

Then, when you get up to 5,000 foot density altitude performances, you notice you are losing 100 feet here, 200 feet there. And all performers, I'm sure, keep a critical altitude where they won't go over the top of a looping type maneuver unless they have a certain amount of altitude. They won't initiate the maneuver unless they have the correct airspeed, and so you start working your way up to the Renos of the world.

Stead Airport in Reno is above 5,000 foot elevation and I've seen days out there when we had 10,000 foot density altitude. When I go into that arena, I go in with at least 20 practice flights at an adjacent airport, on the surface, to gain the confidence and understanding of my abilities at that altitude. Density altitude flying raises the stakes by significant factors. It is, at least, twice as dangerous. It takes time to gain composure in the cockpit with those kinds of stakes.

I get out to Stead a week before the event and I start pulling and it amazes me how fearful I am at the start of that, saying, "There is no way in the world I can do this." I have never not said that to myself when I first get to those altitudes. "This airplane won't do it." Then you keep working toward getting understanding.

At first, I do individual figures to get the indicated airspeed to see if the figure will work. And I adjust the G to complete the figure, but I always have the indicated airspeed and the figure works. Then, I slowly work my way down to the surface, gaining confidence down at the surface.

Any gyroscopic maneuver low to the ground is dangerous. The margins are narrow and the plane snaps in a different way. So, I take all the dangerous moves out and get used to the ground rush, get used to how much G to put in to complete the figure and get used to it all before I put the gyroscopics back in. Then I'll put everything together.

To fly at high DA, you need to have the ultimate confidence in your ability to be in the low level environment. You have to be acutely aware of your situation at all times, what is working and what is not. And you have to be calm, because – if you are not calm – you cannot make cognitive decisions correctly.

At high density altitudes, the airplane snaps like it never snapped before. It lets loose so much quicker and with less G. It's a whole different touch, a different feel.

Also for me, at high density altitudes, dehydration is a big deal, so you need to hydrate more. Your body is working harder. It is more of an athletic event. It is harder to breath. Your heart is working harder. It is easier to become fatigued. Science says it takes seven to ten days to have your body acclimate to a higher altitude and that seems about right.

Bob Carlton

There is a lot of general information about how an airplane performs at high DA, but there is nothing about aerobatics at high DA.

We had a string of accidents years ago, three or four of them, where somebody obviously did not understand the effects of doing a show at 4,000 feet or higher. [In one instance, the pilot] was doing a square loop that started at something like 300 feet. He started on a down line, then tried to pull out. The plane was still descending, but it was twitching, which is what you would expect when it is basically in pancake mode. Investigators saw the twitching and said they suspected there was a problem with the controls making it twitch. They said it couldn't be stalled because the nose was down. That shows how little understanding most people have of aerobatic flight.

There are several things someone needs to know about density altitude. It is obvious that your engine is not going to perform as well, that your apparent speed will be higher, that it affects your takeoff, your climb rate and your landing distance.

Other things are not so obvious, such as: What does it do to the size of your maneuvers? The answer is that the size of your loop

can go up as much as 50% and I think I calculated these at my home field on a summer day with 8,000 foot density altitude.

If you are used to starting a loop at 300 feet, you'd better start at 450 feet [in high density altitude conditions]. Every radius maneuver that you do is going to go up by as much as 50% because your true airspeed is higher. Until you get comfortable with high density altitude, you need to start your routine as much as 50% higher.

You need to have break-outs in your routine where, if things aren't right, you need to have a place where you have practiced a knock-it-off, go out and circle, get your thoughts ahead of the airplane again, get a little altitude and start over.

We tend to tell people to always fly the routine that you practice, but we forget to tell them that you need to practice these knock-it-off points in the routine in three or four different places where, if you come out of a maneuver, you assess whether everything is as it ought to be. And if it is not, the next maneuver is knock-it-off, go out, make a 180, reposition and come back in. We need to stress that, especially at high DA shows.

You start finding yourself low. In the first maneuver, you come out 100 feet lower than you want to be. In a power plane you think, "I'm just going to add all the power I've got." Then you start focusing on your sequence card...I've actually done that. I found myself upside down at 300 feet, not anywhere near the runway. Finally I snapped out of it, rolled upright, did an abbreviated approach and made a landing, but that was in a glider that doesn't have an engine.

But I was amazed at how long I let myself get farther and farther behind. And, in that overloaded state, all I could do was look at the card and think, "Do what you practiced, do what you practiced." I had never practiced breaking out early. So that became something that I put into my routine. I've got several places where I can fly off the end of a maneuver, make a 180 and come back.

Another thing, people will say, "I just booked a show at 5,000 feet, so I went up to 5,000 feet and practiced my routine." In the summer, that is not enough. You need to go to the density altitude that you expect, which might be 8,000 feet, and practice there.

Bill Stein

People need to figure out a strategy for practicing ahead of time for high DA shows. Mine was to fly my Pitts at 23 inches and 2450 RPM to simulate low enough performance at sea level so it would seem like Tucumcari or Reno on a hot day. You have to start out high and move it down as you get used to the reduced performance.

There are some drawbacks and I really scared myself one day practicing. I was doing a torque roll and – at the lower power – I has just barely made my minimum altitude for the figure.

The thing is that, if you have less power, you have less torque and you are more likely to get into that locked up state where you are sliding backwards and you can't do anything about it. So, there I was, kind of perfectly balanced, with no torque and I got this huge, crazy slide in my Pitts. I was thinking, "I'm going to back into the ground." That is how crazy it was. I pulled the power and it did nothing. Finally, I crammed the power back forward. That did enough to unbalance it. It swapped ends and I pulled out. So I tell people, "Be careful. When you simulate some of this stuff, it changes the behavior of your airplane."

EMERGENCIES

Surviving emergencies depends on you knowing your airplane. Memorize the procedures listed in the pilot's operating manual. Then practice, practice, practice to foster quick thinking and fast, correct responses. You cannot anticipate every scenario, but you can develop reliable procedures and the attitude of continuing to fly the airplane, no matter what. The minute you give up in a low level environment, you are doomed, and a threat to the people around you. Things happen fast and you have a responsibility to protect the folks who come to see us fly.

Wayne Handley

Engine Failures: I teach a 270 overhead approach. I use 1,500 feet for the Extra and the Pitts S-2. If you are going cross country, first of all you are not going to know exactly what your altitude is AGL. But I practice this at 1,500 feet and I've developed an eye for what the altitude looks like and I can comfortably do a 270. I use a 270, rather than the 360 they taught us in the Navy because I can more accurately determine when I am over the point of intended landing flying across the runway, rather than going up it. So I fly over this point of intended landing, do a 270 degree turn, trim it so I am at my optimum glide speed because I do not want to get fast. In the technique I am going to describe, I do not want to get fast.

When I fly over the point of intended landing, my first turn, as I start, that's a little tighter than the rest of it because I want to get in a position, relative to the wing, where I can see something recognizable down there close to that point of intended landing. Then I elongate like a downwind and then I am flying my turn out there as I am turning through 90 degrees and around.

And the reason I don't want to be fast is because I intentionally want to be high. Then I work the slip down. If it looks like I am going to be low, I take the slip out. If I am high, I slip it more aggressively and, then, just in a couple of tries, you can get dead accurate with that technique. So I work on that for a total engine failure.

I talk people through that procedure and encourage them to practice it. The other thing I talk about is the way our aerobatic gover-

nors and counterweights are set up to go to coarse pitch, instead of fine pitch. I want people to practice that technique with the prop control pulled all the way out so they can see how much better the airplane glides and how much less drag there is.

Fire: The thing I want people to think about is, if you have a fire develop in your airplane, you can get higher, to bail out, quicker than you can land and get out of it, in most all cases. Now, what is underneath you? You're responsible, if there is a city, an air show crowd, houses, or whatever, they've got to be your number one priority. You cannot sacrifice them and their safety for your ass. So it's a double edge sword.

A number of years ago, an aerobatic pilot had a counterweight on his prop go. Shook the s#*t out of the airplane, and he was too low to bail out. I don't know if he jerked the throttle back, but he was in the landing pattern when a fuel line broke, or something. Fuel in the airplane got loose, and there was some ignition, somehow, whether it was a backfire or whether he turned the master switch off, which would cause a spark itself, or whatever. But he caught on fire and he died. He didn't have any feet to work with when he got on the ground and the plane got upside down and he died the next day.

Before this accident, we didn't think much about Nomex, but – after it – we all got Nomex, and were very religious about it on Sundays. But, in practice on Thursdays, we are out there in our Levis and tee shirts. But for show, when somebody was looking, we had our Nomex on.

If you are out in the boondocks, where chances of the airplane not impacting anything of value, most times, you can get up and out. Say you are at 700-800 feet and a fire breaks out, you can zoom the airplane. I'm thinking, if I don't have a rate of descent and I can get out of the airplane at 1,000 feet, I've got plenty of time to open a parachute.

Communications failure: I don't spend much time worrying about that since it is briefed at every air show.

Disorientation at an air show where you have cross runways: it is real easy to have happen. You do some kind of tumbling maneuver and pick up the wrong runway when you come out. At Battle Creek, you are flying the show line over one runway and there is a 90 degree cross runway. The audience is in a big V shape coming back out towards the main runway. And someone — I forgot who it was — did some kind of octafluger and pulled out of it and was headed right into the V of the audience. There was no graceful way out of that one, but I think I was some place like Terre Haute on practice day and the audience and blue tents were all on my left and I did a tumble and recovered and flew out of and there was nothing over there but trees. Where'd everybody go?

David Martin

I practice – not just air shows, but if the engine quits here, if the engine quits there – a lot. I do it a lot in my tumbles. The great thing about the tumbles that I do is that, when the power comes off, they will quit tumbling. It is not like you need the power to recover. I try to think of the worst place in my air show, if the engine quit, what I am going to do? Then I practice that. Of course, not at air show altitude, but 1,000 feet or higher. I think of the worst thing that can happen engine-wise, distraction-wise, with that thought, then see what happens.

I know in my airplane, the best way to recover. I also did that when I was flying the Bucker Jungmeister. Of course, it is very power limited. I was doing a lot of stuff at the very minimum speed because I had to. So I practiced in it differently. In the CAP, if the engine quits on top of a loop, [it's not a] big deal. In a Jungmeister, if the engine quits at the top of a loop, it's at 500 feet. The top of a loop is really low and, in the Jungmeister, I am doing them on the deck. It's going to be different. What is it going to do? So, when I fly air shows, that is what I think about and I practice that. And I kind of try to practice the worst scenario of what happens.

And there are some things you can't practice, the things we really worry about, control failure, airplane failure. You can practice a little bit like small control failure, rudder failure or aileron or something, but I think the engine thing is the worst, the big deal.

Seatbelts seem to be a problem. Little stuff like that. You've got to be strapped in. If you are doing a ride, roll upside down and you are a little loose, no big deal. But if you are in an air show environment, it is a really big deal. I just can't look at my airplane enough. I am always looking at it. What is that little problem that is going to sneak up that I have not thought about?

I've never had any serious emergencies. The CAP has that little faring at the bottom and I always thought, "I wonder if that thing gets a little loose if it would get the rudder to hang a little bit? It did that one time and it was on a competition flight and it was not any really big deal, but the rudder was definitely not fully functional.

You know, you can't do it in the CAP because of the electric trim, but I've practiced in other airplanes like the Jungmeister, just landing with the trim. And you can do it in the Jungmeister. The Jungmeister has that good trim system. It is just a trim tab on the back of the elevator. It is not a servo trim. It's just a trim, so it's pretty easy in the Jungmeister. I think I used to do that in the Laser, also. That is one thing I don't like about the CAP. The electrical trim is not fast enough for you to fly with it. It is a little slow.

Warren Pietsch

In the warbirds, we sit down and talk about emergencies quite a

bit. What am I going to do if the engine quits right here? What is the first thing you are going to do to get more performance out of the airplane?

In the warbirds, because of the size of the propellers and the engines, the drag from the propellers in fine pitch versus coarse pitch is a big thing in those sized airplane. So, from the beginning of starting to train in them, if you have an engine failure, you are looking to extend your glide. You want to pull the prop back. You can't feather it, but at least you can steepen it up and increase your glide quite a bit.

So, as we talk about doing aerobatic stuff, say, as you are doing a Cuban eight, just as you get to the vertical your engine quits for some reason, one of the things you can do to try to sustain that energy as much as possible is to pull the prop control back to the aft stop and try to keep some of that momentum. It will clean the propeller up and will give it an instantaneous surge because of the increase in pitch with the rotation. It will give you just a little more pull. And there is a discussion about practicing overhead approaches and simulated engine out procedures in the Mustang and stuff. I don't think that the light airplane guys put as much emphasis into that.

Dale Snodgrass

The only thing in an emergency is that you have to know the airplane, know what to do, and know what the procedures are to do after that. Make sure you know what they are.

We all live with what we call bold face, where you have every kind of key emergency in the airplane committed to memory and you actually physically write them down on a board. It says, "Okay, Fire in Flight, Engine Out Profile," and you go through the procedures. There are like four steps that you need to have in your brain. This is what I am going to do.

Departure, loss of control, spin recovery technique, and so on; all this stuff is laid out. It's in a form and we fill it out and then we review it before we go. On our team, we fill it out once a month and/or if we haven't flown in two weeks, for whatever airplane we are going into. That is whether we are going to an air show or going to do something tactical. It is basically a three page event and that is all committed to memory. So a guy needs to understand the key things he is going to do in an airplane if an emergency happens. That is part A.

Then the other big thing to do is, if you have an emergency in an air show environment, or something happens to the airplane, what are you going to do? The first thing is, you would be surprised what a lot of people continue to press on with. So, we religiously brief that if anything happens, like for instance in a formation event, if a guy has an issue, he calls, "Knock it off," and everybody acknowledges, "Knock it off," across the flight, on our frequency.

So, one's knocking off, two's knocking off, three's knocking off, four's knocking off, five's knocking off. Then we have specific places to go.

When I'm flying with the team, I go on the hot side, which is the crowd side at X altitude, the diamond goes behind the crowd at Y altitude. Then we already have contracts within the team where, if a guy has an issue, we have decided who is going to peel off and go and fly next to him and check him out. So you have all those kind of things.

But if you are a solo performer, you just say, "This is exactly what I am going to do." Obviously, if I have an engine failure I am going to intercept my engine out profile, whatever that is.

So, what is your engine out profile? That is what I do in an emergency.

Bill Stein

The bailout and parachute considerations: here is what I heard Wayne Handley say, "The people who come to air shows today believe they are coming to a safe event. They did not knowingly accept additional risk in their life coming to the air show. You, the pilot, have accepted all of the additional risk in your life and in full. So I would be hard pressed to bailout and let my plane hit the crowd."

Consider that in the whole thing. You decided. You are flying the show. You are accepting the risk. These people are not. That is not how we are marketing. It is not, "Cheat death, come out to the air show," right? And it shouldn't really be, "Come watch the pilot cheat death at the air show." But that is kind of how it is, some years more than others. But it really shouldn't be, "Cheat death, come watch an air show."

Structural failure: holy cow! Control failures in my airplane have been the most minor stuff. I have had to push out of tail slides twice instead of pulling out of them, because I had no back stick. And this is at air show altitudes. This is ten years ago. I was a rookie and still trying to figure out how to fly. And then you push up and climb up to 30,000 feet or something (laughs), roll upright. Okay? Am I bailing out? Then you try to figure out what is going on. Small pieces of plastic have kept me from being able to pull back on the control. So you tell people about it.

Your airplane has to be a sterile environment 100 percent of the time. Otherwise, it's not. There are plenty of stories of things dropping out of pockets into the airplane and getting lost until they turn up in the controls. I can tell stories. I've got all these Red Baron stories, like, having a camera bouncing around and I grab it as it comes back by past me and I ask my passenger, "Have you got everything?" Oh yeah, I'm all good. "Well, here is your huge camera that would be back in my controls."

I had a problem with my Edge on a cross country and I was past Steamboat, past Hayden before Vernal, Utah. It's pretty bumpy terrain there and it is pretty high and my engine stops. I think, "Holy Cow! My engine just stopped." And full rich and all this stuff. And, after about 30 seconds, it starts back up and I'm climbing back up. "Holy crap!" I'm thinking. "What altitude am I getting out?" And it occurred to me that, for all the great intent that I had on having a good bailout plan, I didn't actually have a good bailout plan.

When I get out, my canopy is probably going to hit me, right? So what do I do about that? And it was the second time that my engine stopped and I am descending down to 3,500 feet above the ground, where I am finally going to get out of this thing, and it's like, it is in fact, a bunch of right rudder. Then I jettison the canopy. Then I'm just going to pull it away from me, and stuff like that.

Even an upright, straight and level bailout, I didn't have figured out after ten years of owning that airplane, until the engine stopped. So I talk to people. You think you know it, but you don't. You've actually got to go through all that.

What happened is, there is an AN fitting that goes into the fuel pump. So the line goes from the fuel control selector valve to the fuel pump and from there up into the servo and that AN fitting was aluminum. It was so cracked and broke, and it was literally hanging by a thread. So sometimes it was aligned with the intake, so that enough gas was getting sucked in. At full rich, it was running and I climbed up to 14,000 feet and my engine would stop. Then I'd ride down to maybe 11,000, 10,000. Then it would start and I'd climb back up. This happened like eight times and I made it to Vernal. And when I landed on the runway, my engine stopped. That, whatever it was, two, three Gs plomping down on the ground was enough to break that off and it was spewing gas all over the exhaust, really.

I didn't even figure out that I needed to turn off my fuel selector valve until like I actually understood. I'm looking at all this stuff and I'm thinking, "How can all this gas be coming out of my exhaust. My engine must be really broken." Not, "Holy s#*t! I'm pouring gas on top of my exhaust."

Bud Granley

Some people are adamant, and I should do more. But usually, when Ross and I practice, I am stuck in some places where I am low and I am just going to have to stick the nose down and hope for the best. I think most of the stuff we do is not quite as dangerous as the high alpha stuff, because – if you lose the engine there – it is just horrible.

It chanced to happen to me in a Yak 52. One time, it was just a tail slide and it just came backwards. It didn't flop over. The 52 will do that. It will stay and go backwards a long time. If it is on its back, it



In the warbirds, because of the size of the propellers and the engines, the drag from the propellers in fine pitch versus coarse pitch is a big thing in those sized airplane.



will stay on its back a long time, unless you wrestle it out. You want to wrestle it out when you are right there. Power on, have the controls back and then chop the power. If you are in a tail slide, have the stick back so it comes around right away. If you don't do it right away, I mean, if you just leave the power on and just expect it to slop around, it might come back a very long ways.

One year at Abbotsford, it was low weather and nobody was flying, so they said, "Will you go fly?" And I added a little lomcevak I had been practicing. I could always gain altitude, even doing it at a slow speed, like at 110 knots. I could always gain a couple hundred feet. But this time, I recovered on my back and it just fell and fell. Jesus Christ. Then it came out and I was looking at the ground about 200 feet away. I said, "Be very careful." And I reached down to get the flaps. And I pulled out and did not get any grass stains on the airplane. Then I came in and landed.

My reaching for the flaps was a good idea, but I didn't really look and I discovered later that it wasn't really the flap handle that I grabbed. I grabbed the friction handle. I didn't have time to look. I only had basically from about 200 feet straight down to pull out. The friction handle for the throttle looks like the flaps and it is in about the same place. So I grabbed that and pulled it back.

STRUCTURAL FAILURE AND BAIL-OUTS

Bob Bishop

The day I first bailed out was kind of interesting. I would not have gone and done the test flight in the first place if I had thought I was going to have to bail out. On the taxi out, as I was going toward the runway, I practiced the bailout procedure. To this day, I don't know why I did that.

I went through: Okay, you do this and you do this and sometimes you do this, and you hop out. Which way do you go? Which way do you exit the airplane? In the BD-5-J, Les Berven always said,

“Dive toward the wing.” The idea being to kind of miss this little tail back here. I bailed out once and hit the wing. I bailed out once and the wing just went away from me.

I had never bailed out. I had never even done a practice jump. I always told myself, I should go do a practice jump one of these days so I can see what it is like. And I thought: Nah, I don’t want to do that.

I think the fortunate thing for me in both my situations was that it became very clear at a certain point that the only option was to bail out, or I was going to die.

There are a couple little things that I know are true about bailing out. I was in a flat spin and I had gone through a big checklist and I had a plan. Bede test pilot Lester Berven and I had worked out a plan. If it goes flat on you, you drop the gear, you drop the flaps, you change the power settings, you go to full power, all these things, to try to get the nose down. I went through all this big check list. And the last thing Les had kind of flippantly was, “And if all that doesn’t work, just bail out.”

I got to the bail-out part of this list and I remember going through a feeling, a sinking feeling like: Oh my god, this could be it. And also it got to a point very quickly where I could understand how people can sit and just accept the finality of things. Then I heard these words: Do what you have to do and do it right. And that is what got me moving.

So I would say to people, “Do what you have to do and do it right.” Fear just kind of locks people up. If you lock up, you are not going to make it.

Bob Hoover and I had a great conversation way back at Transpo 72 when he told me a bunch of stories about close calls. He had had eight major crashes. I said, “So Bob, what is your secret to surviving?”

He said, “Well, Bobby, you’ve got to keep flying until it quits flying.”

That was his way of saying, “You never give up. You do whatever you have to do with whatever resources you have to get the job done.” I think, with that mentality, your chance of surviving goes way up. And that is true in any emergency situation, not just for a bail out.

The next thing about bailing out is trying to get clear of the airplane. There have been too many people who have pulled the rip cord so soon that they have gotten snagged on the airplane. Not a good idea.

The last one I had was the most critical bailout because I was at ground level when the engine failed and the plane caught on fire. I had fire in the cockpit. I mean I had to get out. But, I was at tree-top level, so I pulled the plane up and I was able to get over 2,200

feet in the air. I actually called another airplane that had telemetry on me. I was 2,200 feet above the ground level.

That’s enough, but the problem is that the BD-5J has a unique characteristic. If you bailout, it’s not going to fly around and go hit somebody. It is going to fall exactly where you bail out. It will go flat because of the aft CG change when you get out. In the BD-5J, if we have to bailout, that airplane is going to wind up right below where we bail out. The good thing is that, if I don’t bail out over people, it ain’t going to wind up on people. Not every airplane is that way. Generally, they will go ahead and fly off.

The point is to have a plan on which way you would exit the airplane, assuming you still have an airplane left. But, have a plan. And once you get clear of the airplane, if you can get stable, that is good, if you’ve got time. Getting stable is just a matter of putting your hands and arms out. It’s just like flying an airplane. If you are a pilot, the first time you do that, you think, “Oh, this is easy.” It didn’t take me too many tumbles when I did that flat spin way back at Bede. If you’ve got time to get stable, get stable. Also, you’ve got to remember that, in a stable situation, you are doing about 120 mph.

Now, in the first case when I bailed out, I was going away from the airplane. I realized the airplane was spinning right above me. So, I could not open the parachute right away, because if I did I was going to get whacked. So I had to roll over. I got stable and I went into a Golden Knight track. I had seen them do that before. You do like a ski jump. You put your hands back and your head goes down and you actually move forward. The guys do that as a cross maneuver. I had to do that to move away from the airplane. Instead of having your arms by your side, you put them back like a ski jumper. When you do that your head goes down because you haven’t got the drag that you do with your arms way out. Your head goes way down. You can feel the speed build up. Now, you are doing about 190.

So, here is the problem: a lot of people are wearing 150 mph chutes. You do not want to open that thing at 190 when you’ve got a 150 mph chute. There is going to be a Wiley Coyote [type of moment]. You will stop for a second and then all the panels will blow out. And you will go straight on down. I was doing 190 mph when I remembered I needed to go stable again because it was a 150 mph chute.

The next thing is to identify the D ring. Look for it. Make sure you see it. Because there have been too many stories of panicked people ripping their clothes off and not getting the D ring. They just grab something in panic and they are not identifying the D ring. When you pull the D ring, make sure it is a double handed pull. Don’t use one hand to pull the D ring. The reason is, that you will begin to roll. If you pull that D ring and you are rolling you can get



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wrapped up in the cords. So, I looked at the D ring, I used a two handed pull. I had never pulled one before.

You know, you have to have your chute checked anyway, so just go ahead and pull the D ring before you get it repacked. See what it feels like. He's got to repack it. So make sure he repacks it. Make sure that you know currently, what the pull is. I about broke my elbow I pulled so hard. At that fabric weight, they are not hard at all if they are rigged right.

I've got a good chute, but it is not what they call a sleeved opening. It is not your sport chute thing, so it was a hell of a shock, but it felt good. It ripped my Levis open. I had black and blue marks on me, but it felt good.

The second time I bailed out, my leg straps were not as tight as they should have been. What happened is that as I opened, the chest strap was able to come up and get under my neck as that parachute opened and I took a big part of the opening shock on my neck. That could have been deadly. So I always tell people, make sure, particularly, that your leg straps are tight.

When you are in the chute, you can still kill yourself. I remember the first time. I was in the chute and I said, "I can see how people like this." Then another thought came to me: Don't hurt yourself here. So I began to evaluate. It was in Newton, Kansas. The wind always blows there. Before I took off, I was not even cognizant of how much wind there was. Now, I really am particularly cognizant about things in our operation. We do not allow our pilots to fly in situations, or do missions where they might have to bailout where the sustained wind is 25 knots or above. Or, if we see a gust of 30, we do not fly. Even if it is right down the runway, even if it is not a landing and takeoff problem, we do not do that.

This attitude goes right along with the Air Force criteria, also. They do not allow their pilots to do this. Obviously, in war conditions, it is different. But I am saying, when you are just doing flying and training, that is the criteria, because you can kill yourself

easily in the landing and get dragged for a long way by the wind.

Also, make sure that your parachute has what they call a Capewell quick release. That is a brand name. Essentially, some people have a chest strap, but you really can't get them undone without using two hands. And, you might have a broken arm. So these are one-handed clip releases. The idea is that, if you are in a wind, you want to get rid of that thing and let it go. If you are a very good parachutist, there are also ways you pull on the cord and collapse the parachute. And there are ways to do it other than that. But, if you can get rid of the parachute, it is good.

When you are coming down in the parachute, you can undo the chest clip because you are actually sitting on the leg straps. You won't fall out. So one clip is already undone. All you've got to do is to hit the ground and get the other two off. And, actually, if you have both arms broken, that is a pretty easy thing to do.

When you are in the parachute and are evaluating wind direction and that sort of stuff, you are looking for hazards. The first time I came down, I saw some power lines and I thought, "Uh oh!" I tried to steer the chute a little bit and it was not a good thing for me, but that was a special situation. Whoever had rigged my chute had tied the shroud lines off too tight in such a way that I had the brakes on all the time. And I was coming down like rocket and I didn't know it. The chute was on the edge of stalling.

It gets unstable. I pulled my one shroud line, just gently and the thing just went swishing side to side and I thought, "Holy crap! I don't want to collapse the chute." I told the Golden Knights this and they said, "What kind of parachute? You did what?" I broke my ankle on landing. And I damn near broke my back. I thought the damn thing wasn't even open. It turns out that it was because the chute wasn't rigged correctly. And it was a twenty-three foot parachute. I now fly with a twenty-six foot chute. Twenty six feet is a whole bunch more than twenty-three. It is not linear. We all carry 26 foot chutes.

On landing, you don't look straight down. You look out at the horizon. You keep your legs slightly bent and you are ready for what they call the PLF, the parachute landing fall. When you make contact you try to fall off to one side to try to take the impact of the fall. That didn't work for me because I hit the top of a small tree or bush. I hit instantaneously and I bounced. So make sure you've got good equipment and make sure it is rigged right. Don't let somebody pencil-pack it. Just make sure you've got a good parachute rigger and make sure you pull that cord.

Sean Tucker

I walk through my routine from the start of the engine to the landing. But, I also walk through the "what ifs," including structural failures, because I've had them. What happens here? How quickly can I get out of the airplane? What happens in an emergency?

The first thing that happens is sensory overload, because it is almost like your brain takes over all your cognitive abilities to have any reflexes at all. And it just stops for a second. It stops for a second to analyze what is happening. Well, a second is a lifetime. If it stops for three seconds, because you really haven't gone through that in your brain to analyze it already and you can't make a decision for three seconds. So, if you are going 200 miles an hour for three or four seconds, in our environment? Phew!

So, if you walk through emergencies and you incorporate that into your getting prepared for a show, you might decide you don't want to be an air show pilot because a lot of us like to put that thing away, that it is not going to happen to us. I'm proof that no matter how careful, no matter how great a mechanic you have, s#*t happens and things break. So I walk through engine failures. I walk through structural failures and incorporate that into the walk-through sequence.

What I have to say is that people need to be prepared to die in that airplane if you are putting the crowd at risk. They need to think, "Can I make that decision? If I jump out of this airplane going this way, I could kill that crowd." They need to think about that. They need to think, "Am I prepared to go in so I don't go into the audience?" They need to make that decision, at least ask that question of themselves. That is number one.

Number two is, they need to understand what altitude they need if they are completely efficient at extricating themselves out of a structural failure. They need to practice that. How quickly can they get the canopy open? Is the canopy going to hit them in the head? Do they need to duck when they get the canopy open? How quickly can they get out of the airplane? How quickly is the parachute going to open? It is going to open in less than two seconds. How fast am I going? Less than two seconds is 300 feet...that's how far you're going to fall in two seconds.

How quickly can I get out of the airplane? Is it going to take me 500 feet to get out of the airplane? Is it going to take me 600 feet? You have to do the math. From anything above 1,000 feet going in, you are going to live. You've got to decide at which altitude you are going to get out. And if you don't practice your extraction procedures at least once or twice a week, you are not going to be prepared for that emergency. You have to understand what sensory overload is and live in that world and embrace sensory overload. Because once you embrace that and understand that this is a natural phenomenon, the quicker you are going to make your decision when everything comes back. You have to understand what it is going to take.

I personally think I would get out of an airplane and would still live at 600 feet going straight down. I'm pretty sure I am going to live because I am good at this. I think everybody who is an air show performer should jump out of an airplane ten times so they are

comfortable with that. As part of being a pro, you should jump out of an airplane ten times because you might have to. The last thing you want to do is reach up in an airplane and make a decision and, "Holy crap! Where's the ripcord? Or, is it going to work?"

That parachute is going to work and it is going to work in 300 feet. When Kevin Eldridge jumped out, it was great [March, 1994, Phoenix, Arizona]. He broke his arm and people were telling him to jump way before he jumped. He was at maybe 1,000, 1,200 feet, I can't remember; it was years ago. You should have seen that parachute open up. That airplane was in the air 5 or 6 seconds after his parachute opened. And he was going fast.

So, structural failures, emergency procedures: it is not a game, man. You've got to practice this stuff just like you practice your routine, just like you do your walk-through. You've got to have those "what ifs" in your brain. You've got to practice in your mind.

You have to go through every emergency. Because, Hoover says it best: It is exposure. The more you do this stuff, the more exposed you are to catastrophic failure. It is just the nature of it. It is the law of averages. So, if you realize there is exposure here, you prepare for it.

Wayne Handley

Emergency structural failure: one of the things I talk about is what happened to both Sean and I where we lost control of our elevator. I changed a battery in Oshkosh and the new battery was smaller, so I shimmed the battery box with a block of wood. And I went to Kansas City to do a show on my way from Oshkosh and – during a negative G tumbling maneuver, when my nose dropped down and I started to pick up speed – I came in with back stick to pull out and I couldn't. The stick was locked. So I relaxed and jerked and I didn't get anything.

So, because of an accident in the Navy that I was aware of where two guys took off in a twin beech with the gust lock on, from that accident I realized something I would have never thought of otherwise. If your elevator is locked up, your trim tab is now your elevator. And it works the opposite direction from your elevator to kick the elevator in the direction you want it to go. So, when I was headed toward the ground I had the wherewithal to push the trim handle down to pull out, where if I had pulled up on it I would have died.

And Sean, when he had his last accident where he bailed out, his rod end bearing broke. Now he had no connection with his elevator and he couldn't trim the airplane where it wouldn't go into these phugoids. I think that is what they call it where they go into these oscillations. Plus, Sean is an experienced sky diver and he has a parafoil chute in his reserve, in his emergency chute, where I've got a round chute. The only time I've been under a canopy is when I ejected. I wasn't doing it for sport. So psychologically, if I

would have been in Sean's position, I might have tried to bring the airplane back in and crash it on the airport. Pieces of the airplane would have been bigger. And I might have been hurt, where he was not. For his circumstances, he did the right thing.

My deal, where I had the control locked, from hangar flying, basically, I learned that the trim is going to work backwards. That saved my bacon. I told this story at a seminar that I was giving down in southern California. And, after the seminar when I was giving instructional rides, I'll be damned if a man didn't take off with a woman in his front seat of his Pitts Special, within three hours of me telling this story, and have something block his elevator. And, on the third try coming back in, he got the Pitts all slowed up and he was coming in and he chopped the power and he was right there ready to come in and he went for broke. He chopped the power and pushed his trim handle all the way down and landed the Pitts with no problem.

We met, probably half an hour after this, I'm at the gas pump and he says, "You're not going to believe what just happened to me!" He had friends going from Redlands that were already headed to the old George Air Force Base. He was going to take it over there where he had a lot more room, but he gave it one more try and it worked.

WEATHER CONSIDERATIONS

In addition to your full air show routine, you need to design limited routines for two other situations. One is your low show, which can be flown safely when the visibility is okay, but the ceiling is limited. The other is your flat show for conditions that are flyable, but too low for aerobatic flight. A flat show is generally fly-bys with noise and smoke.

Wayne Handley

I really encourage pilots to have a low show all drawn out, wherever their low show is, whether it is 250 or 500 feet. If they can't go over the top for a turn-around maneuver like a half Cuban, then they have to do other types of turns. If they have a practiced air show, they are going to be a lot more entertaining. I use the example of myself not having one and going out and loping my mule around the pasture to try and entertain the troops for five or ten minutes. Then I got back on the ground and said, "Well, damn, I didn't do this and I could have done that. Hell, this is in my sequence and I didn't even do that!" So, if you put just a little thought into it and practice it a little bit, you can do a much more entertaining job of it. So it's a good thing to have in your back pocket.

Bill Stein

I don't have a 1,000 foot show. I have my air show and I have my low show, which is 1,200 foot, which includes all the things I can do with a 1,200 foot ceiling. Then I have an 800 foot show, because

— when they say it is 1,000 — it is always 800. I have a set of things I can do at 800 foot and I'm ready to fly and I have almost never flown at 1,000 foot. I have flown at 800 foot a bunch of times and I have flown at 1,200 foot a zillion times and I've flown in severe clear a bunch of times, too. But it seems like it is always 800 or 1,200.

That whole mix of them wanting you to say it is 1,000 foot when it is not and then trying to get the other performers to know that it is not 1,000, that it is actually 700 or something. That is a problem.

There is a video on You Tube of me at one show where I was not scheduled to fly a solo. The Collaborators were there...big show. "We don't need you to fly a solo," they had said. Then later, "Please, because we've got this weather stuff." Sure. "Great, you're first. You can give us a weather report." So, I go up and it is like 800 feet. Air Boss, says, "Really? What is it really?" And I said... "Okay, what is it actually? Actually, it is like 600." He didn't like it.

Then there is the next call about an hour later that says, "We got a report the AWOS says it is 1,000 feet. Go fly your show." So, cool; it's 1,000 feet. So I go do my thing and I get to the center of the box and I do figure number one, which is on takeoff, which is just a pull over and really the clouds are 900 feet, which is not too bad. I come to the other side of the box and I do something like a reverse Cuban or something, and it's 1,000 feet, maybe. Then I pull vertical for this humpty bump thing, and — at 600 feet — it is really dark and I am in the clouds for over six seconds. And coming out of the clouds after six seconds knowing you've only got 550 feet underneath you to figure out if you are aimed at the crowd or not, is a little bit hectic.

When I got out of my airplane, I walked up to the FAA monitor and said, "Do we have an issue?" And he said, "No, we are all good." So I turned around and walked away. I got suckered into believing it was really good when I probably should have turned around.

Bud Granley

In Canada, if you don't have a low show choreographed, you can't fly the show. That is the rule in Canada. If the weather is too low and you don't have a low show programmed and they don't have it in their hand, you can't fly. You have to have a written-out, high show and a written-out low show for when the weather is down or you can't do your high show. And if you can't do your high show and you don't have a written-out low show, you can't fly. You have got to have a sheet of paper that they see before you ever get there. "This is my high show. This is my low show."

I have a low show for each of my airplanes. It's easy with the Yak. We can stay down pretty low. Basically, you leave out the vertical maneuvers. When the ceiling is down to 1,000 feet, your vertical maneuvers are pretty much out. I've done it when the weather was

down to 300 feet and it almost nailed me. But that was not intentional and that was a long time ago. We don't get in those situations anymore.

It was a horrible at Paine Field that day. We don't do this anymore, but – that day – Art Scholl, Myra Slovak and I all flew, and we all had problems. I checked the weather at one end of the field and it was okay. It was 600 feet. I can do a landing out of a loop at 600 feet. I can pull up, put the gear down, put flaps down, come around and land out of it.

The weather was 600 feet at one end of the field. But, at the other end, as soon as I got the nose up, I was in cloud. Now I had no choice, I had to finish it. So I just stayed on the needle and used the timing and just went around the top and dropped the gear in the right place, and I kind of held it. Then I put the flaps down and just stayed on the needle. Then I could sort of see the runway coming and the flaps had not gone down yet, because I had used the hydraulics for the gear and I had not stopped the gear in the right place to get the flaps.

Anyway, when the gear finished coming out, I looked at the ground and I'm thinking, "Aw, it looks like I'm going to hit the ground about there." I was right over the runway. Then the flaps came out, because now there was enough hydraulic fluid for them to work, and then it went zzzrup and I landed.

Art was doing the same sort of thing as me, trying to get things over with and when he was coming in to land [but he had forgotten to lower his landing gear], somebody yelled, "Gear!" and he put his gear down. Then Myra Slovak got lost above the clouds in his power glider and he drilled around for a while until he finally could come down. So, having a 1,000 foot rule is a good idea. No more mucking around like that.

FORMATION FLYING

Debbie Gary

Formation aerobatics has always been my favorite kind of air show flying. My first formation aerobatic team job was leading a two ship team with Jim Holland. I was a new show pilot, his protégée. He knew how to fly formation from his RCAF [Royal Canadian Air Force] experience in World War II. But he had not done much formation aerobatics until we started flying together. We had some awkward moments as we each learned our parts. And, since he was the senior pilot, we both thought all our mistakes were mine. So, it was a happy day for me the first time we flew a show with the original Canadian Red Team pilots, Bill Cowan and Don Farion.

We had never done a show with another team and we hoped to look good in front of them. They had two little Pitts S-1s and we

had two of the first S-2As. We practiced extra hard. But the harder we practiced, the more Holland fell behind. He was convinced I was screwing up the power settings. It bewildered me because, until then, he had been getting better and better and I hadn't changed a thing. The day of the show, Holland fell back again. So he was giving me the dickens in our debrief, when Cowan and Farion came over to talk to us. They were experienced military pilots and told Holland he was falling back because he was trying to fly too close. His wings overlapped mine and he was fighting the drag from my wingtip vortices. Hallelujah! I was redeemed.

No matter what kind of planes you are flying, you should always have clearance nose to tail and wing to wing. I knew that intellectually, but it came home to me dramatically on one of our formation cross countries. I was flying on Manx Kelly's wing in our Carling Team Pitts S-2As when his ferry tank ran dry. It looked like someone had yanked him backwards with a rope. If anyone had been directly behind him, the planes would have collided.

Regular formation training only partially prepares you for flying formation aerobatic maneuvers. There are all kinds of unexpected challenges that come with holding position (or appearing to hold position) during aerobatic maneuvers and in different positions on a team. In addition to flying lead on Jim Holland's team, I also flew slot on the four-ship Pitts Carling Team and left wing on the Bede 5 Jet Team. Different planes, different positions, different personalities, different problems.

The Canadian Carling Team was a fully sponsored team and we had plenty of time and money dedicated to practice, so we loved mastering challenging maneuvers like the level slow roll, which involved both knife edge and inverted formation. Once we mastered those two elements, it was easy to fly a level slow roll. And we were always trying to invent things that were a little more exotic.

Part way through the 1974 season, we added an inside-outside figure eight. We did the first three quarters of it in our usual box formation, with me under lead's tail. Then, on the 45 degree down line, before the front three pushed up for the outside half, I had to roll into knife edge, add full power, and drop back into the slot below the front three planes. For visibility and safety, I needed to be upright and positive while they were upside down and negative.

Trying to perfect this maneuver was exasperating. No matter how quickly I shoved the throttle full forward, I still dropped back in knife edge. I knew something about it unnerved me and made me hesitate. But it seemed like forever before I figured out the simple cause of the problem. To stay in formation as I rolled into knife-edge, I had to take my eyes off lead's tail and put them on the left wingman until I was in my new position. Then I had to switch my eyes back to lead as I rolled level. It took me weeks to figure that out. But when I finally did, suddenly it was fantastic fun.

Compatibility is a big factor on a successful formation team. If you don't get along, you should never be flying low-level, formation aerobatics together. It is all for one and one for all. There is no place for whiners or superstars on a team. Always be on time. Brief the flight. Fly it as briefed. Then debrief it. Mistakes are inevitable. Own up to every one and take responsibility for fixing them. Then, practice, practice, practice and never get complacent.

Steve Gustafson

When I started flying, my dad taught me formation. I said, "Where do I fly?" because you've got these station keeping things. You've got to do this station and that. He said, "Whoa, let's back off of that. I want you to fly where you are comfortable at first. I don't want you trying to push it in and to think, 'I've got to keep this nose here. I've got to keep this right there.' Hey, I don't want you wandering all over the sky, but I want you comfortable. Over time, you'll eventually, safely move to where you want to be." And that is how he taught me. It worked really well. You learn a lot more that way. If they throw you in there, then it overloads your mind, so you can't process so much information at a time. Well, if you are not comfortable, what's that? That's the first basis of learning. If you are not comfortable, you are not learning. So fly where you are comfortable first, and then work in to where you fly those stations.

Formation aerobatics is just a hoot to me, because flying solo is one thing, but then flying eight feet off somebody's wing, doing loops and barrel rolls and stuff like that, it is a challenge. I've been doing it a long time, but it still never gets old.

The extraordinary leaders are few and far between. It is such a joy to fly with them. When Alan [Henley] led [the Aeroshell Aerobatic Team], he had a way of seeing things way ahead of time. If there was multiple traffic, he would just maneuver us ever so smoothly without us even noticing and he would always have us in the best spot. Mark [Henley] is that way, too. Mark leads our team now. But when he was right wing and I was left, we were always high fiving each other because we were so lucky to be flying wing.

The other part of team flying is that everybody has to get along. I've seen so many teams that were good pilots that could not get along. All that negative attitude. I don't want to hang around anybody like that. Alan and I started this team 28 years ago. I'm the only original member on the team now. Everybody else has come on with me. But one of the first things I tell them is, number one, you have got to be good to our sponsors. You've got to fly good. But if you have a bad attitude, I don't care how good a pilot you are, I'm not going to fly with you. And when we get through flying, we go out and have dinner together. Camaraderie together. And believe it or not, that is part of our debrief, too. But we get along good. Don't get me wrong, every once in a while we might have a little squabble or some heated thing. But I always tell everybody,

it's almost like being married. As long as, at the end of the day, we all go out to eat together.

It does make a difference when we fly a good show. When we fly a bad show, we kind of kick ourselves a little bit. We don't really fly many bad ones anymore, not many. Everybody has come along. We all get along really well. Everything is hunky dory. So far, so good.

In formation flying, the number one rule, I would tell anybody, and you think about this: never lose sight, never lose sight, never lose sight. Three times. Every formation accident that has happened was because they lost sight. The Red Barons lost sight. [Red Baron Stearman Squadron mid-air collision in April, 1998.] Daniel [Heligoin] and Montaine [Mallet of the French Connection] did that maneuver [that resulted in their mid-air collision in May, 2000]. They had been doing that routine for 27 years, or whatever it was, and then they had to change it. I've found that when people have been doing a certain routine for a long time, it's best not to change it. If you do, you'd better practice it until it is tattooed in your brain.

Never lose sight. If you'll watch our act, there is not one time that we lose sight of each other. Not once, not a turn, not anything. The only time is when we down bomb-burst and we are going away from each other.

Blue Sky. I don't know what other teams' lost wingman [procedure] is, but ours is blue sky and climb like hell, max climb and blue sky. There ain't nobody can out climb me if I am max climbing. That is the way we do.

No, just never lose sight and good communication. We always do a walk through. I don't care how many times we've flown the routine, each location is a little bit different. The boxes are different. The box in Peachtree City is different. St. Louis is different. Oshkosh is different. So we always do walk-throughs and we always film our shows and we always debrief. So anybody that is planning on doing formation and teams and stuff, make sure you do those things. You will see something in that film that you didn't see in the air. Oops! I need to do this or that.

We do a twilight show and twilight is one thing, but sometimes we get pushed into a little darker situation. What happens then is that you have to be careful of your sight picture.

During the day, you have a certain sight picture that you are comfortable with and you like that sight picture, and that is what you are always striving for. Well, as it gets darker, you still want the sight picture that is in your mind. All the sudden you realize, "Holy Crap! I am flying close. I am flying too close." And the reason is that you are wanting to see that plane that you are flying on, just like in the day. You might think, "I'm not going to," but your mind is going to be telling you, "I need that sight picture that I am



used to.” And you’ll inch in and – all the sudden – you will find yourself flying three feet closer than in the day. So be careful and wary of that.

So, what we actually do, if it is getting darker than we think it is going to be, Bryan [Regan] and I will tell each other, “Hey, it is going to be darker.” Get your sight pictures clean and the same old golden rule: If it doesn’t feel right, lean towards safety. Go the other way, go toward safety. Don’t push a bad situation and hope the outcome comes out the way you want it to.

I find learning does not stop at the airport. Listen to people who have been there and done that. Listen to their stories. That is where I learned a bunch of mine. If you have a close call or something like that, share it. It saves lives. Don’t hold onto it. Don’t think, “I don’t want somebody to know I did that.” Uh uh. Share it. “This happened to me.” Guess what? Everybody perks up, Oh s#*t, I’m going to watch for that. I ain’t going to let that happen.

It is like crop dusting. I have been crop dusting forever. We have a pass program and it is all about that. Most of the two hours we spend in there is all about, “Hey, watch for this. I was going into the sun...” It was all those different things that you learn from. Share your stories, the good ones and the bad ones. Somebody might live.

Bob Bishop

I was hired by Red Baron to go back and look at their accident [in Kissimmee, Florida in April, 1998], to see what was the cause of that accident, to see if we could eliminate the thing from happening again. And to see if we could put the team back together again.

There was a maneuver when all of them would go and do a spread diamond formation into a looping maneuver. They would all roll the same direction, then come back into a formation during the dive back to the ground. The problem is that Randy [Drake] on the outside, he rolled the same way that everybody else did. That means that he lost sight of the lead airplane. This is the airplane

he had to reform on. And he hated that maneuver. They practiced that maneuver 197 times. They kept really good records. One thing about the Red Barons, they did really good documentation, a lot of video. Randy hated that maneuver and he kept saying, “I hate this maneuver.”

Well, that should be a red flag if somebody hates a maneuver. The reason was that he was losing sight of the lead. If he didn’t fly it quite right and wound up on the high side, everybody was below his wing. He could hardly see anybody. He had to get down and he didn’t have [visual] acquisition with anyone yet. And the problem was that all of those airplanes were identical, including the lead airplane. And I am quite convinced that what he did in this particular maneuver was that he acquired an airplane he thought was the lead airplane. Well, it was Bryan Regan on the other wing. So he was closing on Bryan thinking that was the lead airplane and flew the plane right on top of Sonny [Lovelace] and damn near getting John Bowman in the front airplane. Just missed taking three of them out.

That is a maneuver with a flaw in its design and that became a part of the corporate culture of our talk at Red Baron. If you see it on other teams, somebody is going to get hurt.

Daniel [Heligoin] and Montaine [Mallet]: design flawed maneuver, because – on the way up – Daniel was supposed to do a half roll. Then they were supposed to do a split away from each other. Here is the problem. They had practiced this and they had, again, a corporate culture where the leader always called the maneuvers and/or the pulls, or whatever. That is not correct. It should be the person who has to take the cut or maintain the clearance that makes the call.

I taught this to the Red Barons at the time. They were, “Oh, the leader is supposed to make the calls.” I said, “No, no, no.” They did a maneuver where they used to come around with two airplanes right down the show line, turn heavy 90 degrees going away from the crowd, then one airplane would slip behind. Then they would do the twizzle roll or the split always going away from

the crowd so it was safe. The problem is that they had the lead airplane on that always calling the split.

He doesn't know if the airplane is clear or not. And he shouldn't be pulling until the guy who knows he has to clear is clear. In the case of this, Daniel had to know, when he did that roll going up, he was slightly skewed toward her. Their wings were overlapped. I know he knew that, but she called the pull and pulled. And there it was. That is a design flawed maneuver.

In the case of the Red Baron thing, I saw that, I don't know how many hundreds of times, trying to analyze exactly what happened. Then all the sudden I realized, "Oh my God," the light bulb went on.

And when I first saw Daniel and Montaine, I knew exactly what happened. They had this idea that the leader has got to call the maneuver. They call the maneuver to set the maneuver up and to pull into it, but if there is some point during the maneuver where there is a clearance required by a wingman, the wingman calls the break. Simple, but deadly, if you don't know that.

Bill Stein

If you are a full time air show professional, you probably get enough time to practice, but – if you do it on a part time basis – it can really be difficult to set aside that practice time. That problem is geometrically increased when it comes to formation flying because there are multiple people's schedules and budgets that come into play.

There are pretty minimal procedures for most of the teams. I think there should be a discussion about formation team procedures and responsibilities and add a bullet point to the ACE evaluation checklist of, "What are the trade-offs?" Teams have to really think about the risk analysis and not just say, "Oh, we can't afford to practice, so we are going practice once before each show." Or, "We practice so much so that we know that nothing bad is going to happen, so we don't have to worry about that." Is overconfidence scarier than a team that doesn't practice frequently, but does walk-throughs three nights a week? Everybody needs to think about that.

But I think there should be an emphasis on that during the evaluation. When most people get their card, it's in a two ship with a minimal sequence and all you've got to do is not crash and you get our card, pretty much. Formation flying is the one type of flying where experience and procedures are most important to safety. You have to know what you are supposed to do and what everybody else is going to do, you have to be able to fly with real precision, and you can never have a moment where you lose situational awareness. Flying formation, everybody in the sky is risking their lives on the performance of the rest of the team.

Formation flying is all about fundamentals. You need a thorough set of simple rules that everybody knows inside and out, and you need to be able to make tiny corrections that keep you within a few inches of where you want your airplane to be. It is a process of constantly making corrections and getting back into position. On top of that, you want to spend so much time with the rest of the team that you develop a common style of problem solving, so that - when problems do occur – everybody behaves in a predictable fashion.

What you have to do for an evaluation is to demonstrate your sequence and it has to include a loop or a barrel roll, a wingover. There has to be, if the ACE wishes, a demonstration of an out and there has to be a demonstration of a rejoin. Most sequences are about that simple and are just designed to pass the evaluation. A rejoin in the sequence would be a good thing, because that is where you really see how somebody is going to do it.

I have worked with guys to get them cards, their formation training. I've done it a lot. Everybody comes back from a flight and talks about how the maneuver they are learning is going, and how good they are doing at the other figures that they know how to do. I always can tell that they are starting to get some maturity as a formation pilot when they start to brag about their good rejoins. I tell them, "Here's how you know you are a formation guy. You fly the most bad ass sequence that anyone has ever flown and when you come back, what you say to your pals is, "Yeah, did you see my rejoin?" That is the day you are a real formation guy.

PHOTO FLIGHTS

Bill Stein

The other thing that should be covered because it is the scariest thing that pilots do – and they all do them – is photo flights.

You see the craziest stuff because everybody will do something for the camera that they would not do otherwise. Everybody. I have never met anybody that says, "I haven't ever done that and I won't ever do that." The biggest names in the air show business are the most affected by the camera and their ability to let go of situational awareness.

People will do stuff, and I've flown with all of them, and nobody has not had a huge, major screw up. Everybody will roll inverted and fly formation off of a photo plane even if they have never ever attempted inverted formation flight.

One guy was leading a three-ship formation and coming up behind the cargo plane used for the Leap Frogs. He pulled all three of

them into the wake and did a pretty much uncommanded thing with guys tight on him thinking he was leading them into a safe environment to conduct their flight into.

What people do is, they don't understand their responsibilities. So the Red Barons wouldn't normally do photo flights with other guys. Then we did one, but somebody else, not John Bowman, was leading. On one photo flight, I'm right wing and I'm so far in the wake of the photo platform aircraft and I know I am not very far behind the photo ship, so there is no way I can be in the picture in the first place. And second, the guy leading us doesn't know that I am right behind the photo plane. It was scary that he didn't know how close the formation was to the photo plane.

The whole thing is that stuff has happened. I try to put myself in a defensive spot. And I've seen enough scary ones that I'm always the guy trying to say, "Why don't we make this one that we can survive?"

I actually have said to people, "Is it worth killing me to get your picture taken?" And that is people that I've been with on teams. I've said that more than one time. And reasonable conversations ensued. But it is even different than ego. It's just the nature of photo flights. It's not the nature of people. It is almost that, once someone is behind the camera, the camera is talking and it is not even the photographer. I know guys who would say no to an experienced photographer if he asked them to do something they didn't want to do. But, when that camera asked for it, it is a whole different thing. It is like, "Okay, I'll think of how to comply because I'm on this photo flight and I'm trying to comply."

So there are egos, definitely. And the guys without the egos are still doing the same thing. I think it is a detachment thing. It is a particularly insidious activity. And, even knowing how insidious it is, you still do really stupid stuff and it just keeps going. It should be a thing that is discussed at various ways at ACE evaluations. The ACE evaluation is about, "Are you going to be a safe pilot?" Photo flights are not safe.

I was on a photo flight with a guy who was supposed to be responsible for separation from me. They had a photo flight with six guys and one photo plane, the guy next to me is looking at the person outside of him. He has got his head turned more than 90 degrees away from the pilot who he is supposed to be flying off of. It shows in that picture. I said something to him and he said, "No, I would never do that." And I showed him that picture and he said, "Oh my god." Actually, what he was trying to do was, he didn't have confidence in the person outside of him, and he was trying to defend himself. But he just lost his situational awareness because there is all this stuff going on and that is the nature of photo flights.

I just consider every photo flight to be a potentially stupid endeavor. I cannot tell you how much respect I think you should give to photo flights.



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We did one at an early season air show that was totally nutty. The photographer wanted a shot where we were in a steep turn in echelon where we are stacked up. We were flying these mid-wing monoplanes where we can't see much below us. And so the photographer says, "Can you do that?" And we talked about it on the ground, then we are looking at where the photographer was at, and we put Jack [Knutson] in a spot where he could keep track of Matt [Chapman], and Rob [Holland] and I were going to stack up on top of that.

What Rob and I did was brief, "If we were going out at the same time, there is a likelihood that just a big bump or a 20 degree unexpected bank angle change on the photo plane is going to make Jack and Matt descend to the point where we are going to lose sight of them before we understand what is going on. So, if we have a planned lost sight and an out procedure for this shoot then we can try it." And we actually did execute the plan because we did start to lose sight. We talked about it, we briefed it, and our out was executed just the way we wanted, and we are all happy with it, but we are not going to do it again.

It was plausible and, because he asked us the day before, we spent some time talking about it at dinner and we thought about it. Then, the next day, we talked about it some more while we were sitting around waiting to fly. Then, during the briefing, we kind of expressed our final plan and we were finally ready to execute it and it worked out pretty good.

When I flew on the Collaborators with Sean Tucker, we learned a lot of stuff together and one of the things was photo flights. I told him. "We need to go practice photo flights or we are not going to do them." We actually dedicated two days to it. We got Brian Norris down in the Seneca [as the photo platform aircraft] and we decided what we were going to have for our Collaborator poses. Then we were going to do that. And we really briefed our set-up and take down process. We all knew our responsibilities and we did it. We set aside two days and we practiced our photo flights. Then, when anybody else was on the photo flight, it was only if we all felt thoroughly briefed and that the walk-through was with few

enough errors that we felt confident enough that the flight could run smoothly. And we checked in with each other at the end of the walk through.

The tops guys have realized that sharing of media gets them more media. So many guys have done it with us enough that they are adopting the procedures. The photo flights are, in general, getting better, but everybody should be very careful and have a thorough brief on photo flights.

CIRCLE THE JUMPERS

Greg Shelton

I always try to talk to the pilot and skydivers ahead of time. The main thing I want to know is, "How many are jumping?" Then, I explain to them: "Okay, if you say there are three jumpers, then when that third guy comes out, I'm rolling in right behind that airplane and starting the descent. I don't want a fourth guy jumping out and hitting me."

The other thing that I try to make clear to the pilot [of the aircraft from which the parachutists jump] is that he is going to continue on in a straight line and leave the area, so I don't have to worry about him. I had a guy, after they all jumped out, he rolls right into me, rolls over and heads on his back like he was trying to beat the guys down. After I told him to fly straight out, he rolls over and comes right into me. I jerked back and went right over the top of him. So, that is another thing you have to be careful of.

The other thing that I don't like is when they free fall. I've had them jump from high altitude and then pop their canopies about 4,500 feet. If they don't have smoke, a lot of time those guys are hard to find. You are down there at a lower altitude hoping they are not coming down on you. I kind of quit doing that where they were free falling from high altitude.

Have them jump at 4,500 feet, then circle them, because then you can see them. You know where they are at. I think somebody in a Pitts hit somebody when they did that free fall once. I think they were free falling and the pilot was trying to find them and ran into them. That is the thing I don't like about free falling.

You kind of know where they are going to step out because of the wind, but it seems to me that they have always been kind of hard to spot if they don't have smoke. If they are going to do a hop and a pop, you can be right there with them.

Then I've always stayed above the highest one so I don't dirty up the air for them or anything like that.

When there are other planes, step up on one another, so that whoever is leading the bunch doesn't start getting below the sky divers. It is just like you are in echelon flight. You are skimming just outside of the smoke of the guy ahead of you. If there are

three of you, you might be at three points of the compass. Just follow a guy's smoke. Watch the other guys and all the sky divers.

Bud Granley

One of my friends circled the jumpers at an air show and it turned out that he hurt his neck pulling about six or seven Gs. He had to stop doing air shows for a while, go to a chiropractor, and go to therapy. I can see that happening if you are going to circle the jumpers, looking back at them, while you are turning at 7 Gs. He put his neck out of kilter and sprained some muscles and strained some things.

I suggested to him that he fly slower and keep the Gs down, and he did that afterwards at another air show. Keep your speed down and you can still fly close enough to the jumpers. Seven G, eight G, pulling around the turn is actually dangerous for the pilot.

Circling the jumpers is a fair amount of work. You've got to prepare. You've got to go fly. You've got to come back, smoke up again and refuel for your main act.

You circle the airplane and don't get involved with the airplane until their chutes are open. There are certain rules about circling the jumpers and one of them is that the jumpers have to be accounted for before you approach them.

Here are some of the things you have to do: You have to brief with the jump pilot. You have to brief with the jumpers. Those are the rules. How many jumpers are going to be out? It has to be totally controlled. It has to be totally open.

DOGFIGHTS, TAIL CHASES AND ASYMMETRICAL ROLLING G FORCES

Bud Granley

We used to do dogfights with a couple T-6s and sometimes we would take up a couple Golden Knights, the Canadian team jumpers, or the girls from California. They would sit in the back. We would put them sideways on the seat and then go up and do a fake dogfight, then turn over and let them fall out. And they would all fight to go with us.

The main thing was to not have them hit the canopy on the way out. But it worked wonderfully. Then you would put the smoke on and they would bail out and you would disappear over the hill. I think dog fights are very neat.

I do a mock dogfight every year at an air show where I fly the Mustang and another guy flies a Zero and, of course, the American plane has to win. We take off and go up northbound about

three miles and turn around and on the way back in and say, “Split now.” So he goes 45 degrees and I go 45 degrees, then we come on back in and we meet up at the opposite end of the airport and then the fight is on. I turn tighter, so I usually win in a couple turns and the Zero turns on his smoke and disappears. Then we come back and do a couple passes. That is a mock dogfight.

I’d like to see a real dogfight, a contest with rules. You can start here, and don’t go below this altitude and the winner is determined by a judge on the ground.

I did that sort of thing with Bill Reeseman with his MiG 17. He came in fighting my Fouga and when I said, “I got you,” he said, “You lying bugger” and I said, “I’ve got the video.” So we set it up another day. We did kind of a Wrestle-mania thing on the radio beforehand. Like trash talk. We talked it up for the audience, about the competition, what it was going to be. Kind of slurred each other. It was marvelous. I think it has great possibilities for entertainment.

Skip Stewart

First of all, there is dog fighting and then there is what I would call more of a squirrel cage. Tinstix is not a dogfight. The show that I fly with Melissa [Pemberton] is not a dogfight. It is a very choreographed sequence. We know exactly what we are doing every time. It is the same every time. We know who is responsible for timing, if timing gets off. Melissa and I are using dissimilarities to fly together.

She is responsible for changing position, and I try to be consistent every time. If we are show left the first time, she makes the adjustment to bring us back to show right. And I stay the same because, if we were both making changes, it would get messed up.

Tinstix is 100 percent choreographed. There is no unplanned maneuvering at all. The risk of unplanned maneuvers is misunderstandings. I keep flying the sequence the way it is supposed to be flown, as choreographed. I think that is really important. Keep flying the show as briefed, until you know what is going on, even if you don’t see the other person. They might have a communication failure and you turn left and he turns right. So I think that is really important.

And I think it is really important that you do a lot of communication when you are doing those acts. When I am flying, I am talking the whole time. It is somewhat of a conversation, but it is mostly me just talking. I call what maneuver is next, when I am starting the maneuver, when I am starting the tumble, when I am snapping. I call contact when I see the other plane. They call contact when they see me. If anything unusual happens, like there is a lot of smoke and I am supposed to be in the grass and Melissa is supposed to be on the runway, I will reiterate that. “I am crowd side

in the smoke.” So there is absolutely no question who is where and why.

So, that is a choreographed multi-ship. I’m not even sure what the definition of a squirrel cage is. But that is kind of a squirrel cage issue, when you have two planes head on toward each other and we crisscross, too. When we do Tinstix, we use highway rules.

If I am coming at somebody I am going to go to my right and they are going to go to their right. I am going to pass to their left, and they are going to be to my left, every time. If we are nose to nose, there is no doubt which side you are going to be on, because it is the same every time.

You cross each other, then you go to the opposite end of the box, do a maneuver. Then when you come back, the issue is that you have to go to the opposite side. You have to get to the opposite side from what you were on before. You’ve got to get on the opposite side of the road. But the good news is that you don’t have to ask yourself, “Am I on the downwind side this time?” If you are nose to nose with the other airplane there is absolutely no question where you are supposed to go. You want to get rid of as much of the ambiguity as you can.

Not only do I feel extremely confident that the Tinstix act is safe for the public, as well as me, as far as the design and communication itself, but it is actually so simple that I feel comfortable flying it with multiple people. And it is easy to teach: walk through it three or four times on the ground and you fly a loose sequence once, and you are ready for the show. That is how easy it is. From the crowd’s standpoint, it looks chaotic. Anyway, that is how you choreograph that squirrel cage, head on thing.

Now, I do dog fighting, as well. And the reason I do dog fighting is that, when people hire John Mohr or Gene Soucy and me, we’ll do a dual act. Their aircraft are so dissimilar from mine that it is impossible to do the choreographed Tinstix show with them, like I can with the high powered aircraft. Their airplanes are so slow and they can’t maintain the energy to just do the maneuvers themselves. So we came up with a completely different show, really.

The dog fighting is definitely more of a risky situation because it is not choreographed. Communication is important and, as much as we can, we use highway rules, so we are always passing nose to nose at the same time, but it is not choreographed. It is a constantly evolving thing and you could have the possibility of getting into a situation that is ambiguous and it is not clear which way the other person is supposed to go. Location is the key to that, totally. I’ve done it with John Mohr and Gene Soucy quite a bit. I’ve done four or five shows with Gene and twice that many with John, and what a tremendous honor to fly with those guys.

With the Stearman, I say, “I am always going to pass you on the crowd side, no matter what. If we are heading for each other, I

will be closer to the crowd, so you just fly out like on the 800 foot, 1,000 foot line and I'll fly the 500 foot line while we are turning around. And if there is enough time while we are pointing at each other to get close, we'll get close. But I am always going to pass you on the crowd side."

We do two or three minutes of that, because, about that time, people get bored with us doing a dogfight. And, about that time, it has decayed into one person chasing the other person's tail. So we split apart and do some choreographed stuff. And the choreographed stuff is always based on the lower performance airplane's capabilities. With Gene and John both, I say, "Tell me three or four maneuvers that you can do in a row without taking a break." It would be like a loop and then a barrel roll and then a four-point roll. Something like that might be all their plane can do. Then, I would take my plane and say, "How can I fit that into this?" For example, if John did a loop, I would do a loop with three snaps on top. Gene and I did the same thing. It looked really good. Opposed, highway rules loop and I would do a loop with three snaps on top and mine would be a little bit bigger than his, but entering at the same time and exiting at the same time. It worked really well. Then we would do a four point roll at each other. They would do a barrel roll and I would do an arcing centrifuge at the top...whatever we could do to show off the dissimilarities of the aircraft.

I would pull up on like a 45 degree angle, while they are doing their barrel roll low to the ground and I'm doing an arcing right-right, eight, ten shoulder rolls in an arc across the top of them. A series of shoulder rolls high speed.

So, what can I say about dog fighting? Just dog fighting is going to get boring, so we do a mixture of dog fighting and choreography. The main thing is that you've got to have a game plan before you go. Who is responsible for missing who, and a kind of briefing for a formation flight. If we are nose to nose, what are we going to do? And it needs to be easy. We need to use highway rules. Or, I am always going to be on the crowd side. So that is just stuff that I do that works for me. Just because I do it, doesn't mean it is the best way.

Another thing, with Tinstix, is pyro. When there is no wind or a slight on-crowd wind you can smoke out the runway, pretty easily. This is the only issue we have with pyro. So we usually have someone on the ground to say, "Turn off your smoke," because with the airplane smoke in conjunction with the pyro smoke, sometimes you just smoke the place out. Then nobody can see what is going on. So there will be somebody to tell us to turn our smoke off so the crowd can still see us.

Most of the time, we can still fly through the smoke. But flying over the top of it is also an option. But we still brief that, whatever our track is, we are going to stay on highway rules. One person is

on the runway, one person is on the grass outboard of the runway. Stay on that. You can fly it high over the smoke, or you can fly low in the smoke. Sometimes, turning the runway lights up helps, if the lights are in a position where they will help you out. If you expect the smoke to be an issue that day, because of no wind or slight on crowd wind, ask the airport to turn the lights up high. Then, when you go through the smoke, you can see the lights for separation.

As far as the pyro itself, you've got to treat the pyro folks like another performer. If there are two airplanes, a truck and pyro, then there are four of you and all four of you need to be in the briefing when you are walking through the show. Rich Gibson, of Rich Incredible Pyro, was always at every briefing. We would do the walk-through and we'd go through it two or three times. He'd say, "Boom on Skip, boom on Melissa, boom on the truck."

In any briefing, there are situations that come up. "Well, what are we going to do about this, because the wind is from that direction?" Or whatever. And you have to clarify that then. Like sometimes, you have to do an extra pass to get in position for the truck and the pyro guy might be unclear. "Now, is this going to be the wall pass or is that one?" Sometimes I just call on the radio, "Wall pass, wall pass, wall pass." If the pyro guy wasn't there during the briefing, he might have the wall of fire going when we are just going down to get the truck. Just things like that. Not necessarily safety things, as much as making sure the show is quality.

I would just say that if anybody is uncomfortable with the pyro, just know where the pyro pit is and don't overfly it. That is the easy way. If you don't want to get blown up, or don't trust the guy blowing things up, don't fly over his stuff.

Dale Snodgrass

If you are going to do dog fighting, it's important to understand the difference between normal G forces and rolling G forces.

Rolling G means – while you are pulling G – you are actually rolling the airplane. You don't have the stick neutral; you have lateral stick in, left or right, while you are pulling back on the airplane. So, in war birds and jets, say the airplane is stressed to plus 7 Gs. So you've got a 7 G airplane. That is based on pulling the stick straight back. If you roll the airplane while you are doing it, it causes asymmetric G or rolling G. Then the aircraft capability, structurally, is generally about 2/3 of what it's normal G loading is. So if you have a 7.33 G airplane, then your rolling G is normally around 5. So, if you are doing a lot of heavy G activity while you are rolling the airplane, you can be overstressing the airplane significantly.

You get a lot of these places that do dog fighting. They had a few accidents with T-34s a few years ago, because when they did that, everybody was rolling and pulling at the same time. Over time, the

fatigue comes up, the wing comes off, and two people die.

Now, if you are flying an Extra with a 12 G limit with ridiculous G loads on the airplane, it's not that big a deal. But, if for instance, you're in a Marchetti, you definitely want to pay attention to [asymmetric G].

I'm flying one privately, frequently. We'll go out and do some formation and out of control flight with Navy Seal pilots and we wind up doing some basic fighter maneuvering, dog fight stuff. It's very easy to get up on the rolling G limits of the Marchetti. Even if you are not particularly nose low.

Also, configuration issues are important, flying with tanks versus a clean airplane. If they put smoke tanks on, smoke generators and have all that hanging on the airplane, it impacts your overall performance.

I ask guys, "What is your drag count? How is that going to impact you?" Guys with tanks, "Are you going to put fuel in it?" In my F-86, I put smoke oil in one of my tanks, then I put a little gas, 35 or 40 gallons in each one. The bottom line is that that impacts your overall G capability of your airplane, therefore your maneuvering airspeeds and all that. It impacts your overall performance.

In something like a Marchetti, you are not supposed to do aerobatics with fuel in the tip tanks. The impact is probably not going to be seen right away. The impact is going to be seen in the fatigue life of the airplane, so you eventually could have a structural failure if you don't pay attention.

If a guy is not taking care of his airplane and checking it, opening it up and looking at the spars, looking for cracks, and all that kind of stuff, he can wind up with wing failure. And that all plays into anything you do. If you have fuel in the tip tanks and you do that, then it goes right back to the rolling G and the asymmetric becomes even more critical. Because now that tip tank is out there in a rolling pull. If you go to your G limit of six and a half, or whatever the G limit of the airplane is, say seven, the part of the airplane that is on the outside of the roll could be experiencing as much as ten Gs. And that is where the structural problem comes in, the outside of the roll rate. It is not something that develops into an instantaneous crash, but it is a long term fatigue life structural issue.

Julie Clark

Real dog fighting is all about getting the other guy in your piper, getting him off your ass and you getting on his. And that is all about opposing, tight turns and doing impromptu maneuvers, impromptu G pulling. And you are pulling way more than you are expecting because it is all impromptu. Nothing is choreographed. Nothing is planned.

Pulling rolling Gs, asymmetrical G forces, is so hard on these old

trainers. I guess they were doing that a lot in the combat training schools, turning around real quick to get on the ass of their opposing guy. And that is what hurt the T-34s, doing asymmetrical rolling Gs over and over.

Personally, I would never take part in dog fighting because most of the warbirds are not fighters. They are trainers, generally speaking. Not all of the warbirds. There are Mustangs and stuff that were built for it.

That kind of flying is so hard on airplanes that there should be a life expectancy to that airplane. These impromptu G loads really take a big hit on metal fatigue, aging aircraft. That's huge. Then you are going to start having things fall apart.

I learned a lot about that because my airplane became the fleet leader of the T-34s, to keep me in the air show business. I had to go to the FAA in Washington, and say, "This grounding of T-34s is personally affecting me and my business and I'm going to go out of business because you are grounding all the planes. It has nothing to do with us. It was all these air combat schools that lost three T-34s, killed six people in a period of about five years." Finally, the fatigue was setting in, in these airplanes. It took nine years and finally — like a coat hanger that you keep bending — it's going to break. So we started losing airplanes and the FAA would not look separately at us air show people, like me and Lima Lima.

We fly the way these airplanes are designed to be flown, not with more Gs and the rolling asymmetrical Gs, which tore the air combat airplanes up. They were abusing them.

Metal fatigue versus overload are two different things. Overload is the worst thing, like these asymmetrical Gs. They are really hard on an airplane. And accelerated stalls, where you pull as hard as you can and take an airplane to the buffet.

RIBBON CUTS

Inverted ribbon cuts are thrilling to watch and even more thrilling to fly. They should be performed only by pilots who have extensive, successful experience flying upside down, low to the ground. Two things are essential. One is a level inverted flight path leading up to the ribbon. A descending arc is sometimes impossible to stop, so you could sink into the ground from your momentum or from unexpected descending air. The other essential is maintaining an airspeed that is high enough so you won't hit your tail as you push your nose up to climb away from the ribbon and high enough so you could roll right side up if your engine quit.

Sean Tucker

When I first started out, I thought you had to be real low because I thought that was the way the old barnstormers did it. My poles were ten feet off the ground. Then one day Charlie Hillard said,



It is important to keep scanning and not fixate on the target. Pay attention to the entire environment.



“Why are you being so stupid? You don’t need to be that low. Put them up.” So now my ribbons are at 23 feet.

I certainly did not do a ribbon cut when I first got to the surface. I had a couple years under my belt. You need to have a low level box and you need to get used to it, to be down there hundreds and hundreds of times. And you need a guy on the radio to critique your altitude, to help you practice that stuff.

Ribbon cuts are not easy and they are dangerous. Wind is an issue. Density altitude is an issue. Is the wind too strong? Is it too gusty and bumpy that you need to knock it off? Sometimes people get bore-sighted, thinking it has to be completed. They get laser-focused and they start chasing it. You’ve got to realize that this is just a show. It is just entertainment. You don’t have to do it. If the winds are too strong and you’re not lined up, back off. You don’t have to do the ribbon cut. Over the course of 23 or 24 years, I’ve knocked off ribbon cuts four or five times.

Skip Stewart

It is important to keep scanning and not to fixate on the target. Pay attention to the entire environment. Pick something to look at on the other side of the target. If you fixate on the target you could follow it into the ground.

I like to see the ribbon before I roll in on it. I roll, then I take a picture of it with my brain and make sure that doesn’t change.

A lot of people use a length of string that is greater than half the wingspan on each ribbon pole and put the ribbon in between. That way, they know that if they touch the ribbon, there is no way that their wing is going to touch a pole. I don’t do that. I put a target in the middle and I aim for the target. I like to be precise. If I hit the target, I am far enough away from each ribbon pole.

When I first started, I was just going to do some low passes at 20 feet. I rolled inverted and came down to what I thought was 20 feet and asked my buddies how it looked. They said, “Man you are like 75 feet in the air.” It is pretty amazing how low 20 feet is! Before you do ribbon cuts, you have to be really comfortable inverted.

Greg Koontz

Because the Decathlon has dihedral in its wings, when it is inverted, it has an issue that Pitts-style biplanes and the modern mid-wing monoplanes do not have. Koontz has had several tense moments as he dealt with this during the inverted ribbon cut.

When the Decathlon is upside down, it has negative dihedral. That doesn’t sound like a big deal, but – if you skid the plane fairly hard upside down – it can keep you from being able to roll out. It can pull a wing down more forcefully than your ailerons can pick it up. If you are slow and sluggish, your plane can get trapped there. You are sinking toward the ground. You can’t roll out and you are trapped. It has happened to me twice, but – of course – I knew what I had to do.

You have to release the rudder, but, when you release the rudder, the nose is going to drop toward the ground, so that is the last thing that you want to do, but it is the only way out. You’ve got to release the rudder and let the nose swing over like it wants to, then you can push the nose back up and roll the wings level. So you kind of have to have the guts to go for the ground a little bit. The times it happened to me, I was at tree top level. It was a scary situation, but it would have been worse if I had been lower or slower.

You have to be slow and sluggish for that to happen, so fly fast for that reason and to give yourself enough energy to push up, roll over and land if the engine quits.

You’ve got to be real careful where you set your ribbon up. Some shows put it out on the grass and that becomes two poles sticking up in the middle of a sea of green. And a sea of green is like glassy water. That is a problem. When you are upside down, your depth perception is not as good as right side up. Your brain is working harder to interpret the world. What I’ve done in those situations is to take a piece of my caution tape and make me a long straight line across the grass leading up to the center of the ribbon. That gives me something for depth and alignment.

There is one big air show that makes you put it on the parallel taxiway in a place where, before you get there, you have to cross a bunch of grass. There are rises and falls, ditches and obstruction. It’s hard to gauge my altitude as I cross those obstructions.

Jim Holland always said, “Get level and stable before you cut the ribbon. Don’t go after it.” That sounds like obvious advice, but when you are crossing obstructions on your run-in you feel like you need to keep yourself high until the last minute. Then, it doesn’t take much of a downward angle that you can’t stop before you hit the ribbon. Then you can get suckered into making more corrections than you should. It’s just right there under you. You just want to push down and grab it real quick. But when you get something like that started, you might not be able to stop it.

Then, plan where you are going to go if the engine quits during that pass. Keep up your speed, but be careful where you put the ribbon. If it is too far down the runway, that may hamper your chances of getting back down safely without going into the woods. Some places you might need to cut it from the other direction to give yourself more landing options. Spec it out.

Wind will always make the ribbon bow out some, but if it is out a lot it could break. And wind can catch the ribbon and drive it downward. I tell my ground crew that if my ribbon has a big U shape because of the wind and it keeps gusting it downward toward the ground, that is not acceptable. If it is being blown downward, it may not be high enough. When I roll upside down, I've got about three good seconds of really seeing that ribbon and knowing where it is and I'm going to go for it. So, if you give me a ribbon that is only halfway up, I'm going to be halfway down trying to get it. So, if it is not flying high up there at the top of the poles the way it is supposed to be, then just drop the whole thing and don't give me anything to go for and it will be an abort.

Greg Shelton

For a while, I did the inverted ribbon cut in my Stearman. Then Bobby Younkin told me, "Once you start it, you can't quit and you'll always wish you never started. It is a pain in the neck to haul your poles and to get somebody to hold them. You'll wish you never started it." So, I took his advice and quit.

Jim Peitz

For many years, Jim Peitz successfully did inverted ribbon cuts in his Eagle and in his Extra. Then he experimented with doing one in the Aerobatic Bonanza and that turned out to be a terrible and treacherous idea. It does not have enough forward elevator travel. So his advice is: Do not do it in the Aerobatic Bonanza, not even if it has an inverted system in it. You will run out of forward elevator.

Skip Stewart

I like to have three people on each pole. Most of them will never have done it before. You see pictures of people holding the pole and almost inevitably one or more of them will have one hand on the pole and the other on a camera, even though you tell them not to. So, if I have one person who is taking a picture and one person who is scared, maybe the third person will do their job and keep from dropping the pole in front of me, because that is the most important thing.

The other thing I am pretty adamant about them being briefed on is: it doesn't have to happen. Don't be in a hurry. If you pick up the poles and the ribbon breaks, no big deal. Just lay them down again. Nothing says that it has to happen quickly. I want

everybody to be calm. Don't run. Listen to the instructions and, if the ribbon breaks at any time, that is fine. It doesn't have to happen. It is very important that they don't get excited and run around out there.

Twice, I have had problems with pole holders who were actually my own crew. One guy had worked for me a few times and, since he had done fine, I did not walk him through the process again. And we did not do the ribbon cut on the practice day. We should have, but it's a fair amount of trouble.

But, both times, the 500 foot line was in the grass, not on the runway. This guy had probably done three or four shows with me and I trusted him and thought he was smart enough to know better. At the other shows, the 500 foot line was on the runway, so he would go on the grass with all the people and sit down and wait for my cue to bring the poles on the runway. This time, he walked out and sat all his people on the 500 foot line. I come screaming down for the first maneuver and see seven people sitting in my way.

He had a radio and I said, "Hey, get out of my way! What are you doing?" That happened to me with two different guys. So it is important to have little pow-wow before the show. And practice day is important, too. We would have caught the problem on a practice day.

Greg Koontz

You really have to walk through the whole process with them and have them hold the poles, pick them up, set them back down, get the feel of what they are doing so they don't get out there and make some obvious mistakes. There is no time to figure it out while they are out there.

The poles can bend a lot in the wind. You put outriggers on them, strings from the top. Make sure they understand where to pull on them to make the pole stand up straight. I show them exactly how I want the poles to be stable, how I want the outriggers to correct for the wind, how to keep from breaking it, the mechanics of it. Then, also, I explain to them where I am going to come from. The last thing I want is someone to get scared and drop the pole and try to run because they could bump into me as I'm coming by. I want to explain to them what it is going to look like so they will know what normal is.

I don't allow them to have cameras or radios. You are either going to hold the pole for me, or you are going to be a photographer.

I used to have telescoping poles that expanded in three places. Then one time the crew that had gone out beforehand had collapsed one section and then set them down. Later, they went out and didn't realize that there were three sections and they said, "Well, it's already been pulled out. It's ready." And they picked it

up. So instead of cutting a ribbon 18 feet high, that day I cut one that was 12 feet high.

I try never to have a totally green crew. I always have a minimum of one person out there that I can put in charge, usually more than that.

NIGHT AIR SHOWS AND PYRO

Night shows probably started in the 1920s with lighted railroad flares on fabric airplanes. That probably didn't last too long. Then, Art Scholl introduced the modern night display at the Calgary Stampede in 1974. And, in 1989, Gene Soucy and Steve Oliver reintroduced them more or less as they are today with pyro all over the airplanes. Since then, different people have created a variety of night shows with and without pyrotechnics.

With the night pyro show, the most important thing is safety. It has a higher floor, 500 feet, and higher weather minimums, five miles visibility and a 2,500 foot ceiling.

Steve Oliver

For a while, Gene and Cheryl Littlefield did their wing walking act at night with no pyro, just with lights all over the airplane shining on her. Bill Leff, who is kind of an electronics guy, uses a lot of spotlights and has his pyro fired from a remote control box on the ground.

My Chipmunk carries fountains, also called gerbs, which are what stream out the long trails of sparklers and fire that come off the wingtips. I also carry custom-built, 8 shot 30-mm Roman candles that shoot out colored balls. I encase them in steel tubes and have a big titanium plate that goes on the wingtip before the mounts go on. The titanium gets discolored from the extreme heat, but it protects the wingtips. I've never had an issue with this, but — on a rare occasion — fireworks can go high order. That means, they explode all at once, make noise and shake the airplane, then they shoot out fire balls.

So, you do have to be careful not to fly below the 500 foot night floor for aerobatics because a fire ball could set a field or something else on fire. That has happened to some people.

Your sink rate is incredible with all that drag out there. I mean, the Chipmunk comes out of the sky when you pull the power off. Its frontal area, with all this [pyro] on, is probably six square feet per wing. You can't do near the maneuvers with all that hanging on the wings, so a night show routine is pretty much limited to loops, rolls, Cuban eights and kind of a hammerhead.

One of the biggest considerations on the Chipmunk is how much glass you've got around you. You can't fly with the canopy off, so the reflection from the fountains is incredible. You have got to

have some lights on the ground for reference. We have them turn the runway lights up all the way. But, sometimes, you do a remote show like the one we did at the officers' club at the Pax River Naval Test Pilot School, which is out on a spit of land that goes out into the ocean. That means there are 180 degrees with no horizon, just black water. As long as you can turn toward the lights of the base, you are okay, but often you have to turn away, to avoid flying over the crowd. So you start a 180 going away, then turn back and you look over your left shoulder until the lights go out of sight, then look right, real quick. For a couple seconds, there is nothing. Then you pick up the lights as you complete the turn.

Bob Carlton

I get calls all the time about adding smoke or pyro to airplanes and the first line of my answer is always: "Realize you are attaching explosives to your aircraft that can destroy your aircraft or kill someone else." That is the first thing you have to understand. I don't care how small they are, or if they are just smoke. I have seen the results of a smoke canister blowing up and taking off a substantial portion of a wingtip. That is the first thing.

The second is that electrons are slippery little devils. They will find ways to get to the ignition device of your pyrotechnics, that you never dreamed of. There is no perfect system. If you just run wire from your light switch out to your wingtip, and then a wire to ground your pyrotechnics, you've got a 30% chance that something is going to go off when you don't want it to. And, if you don't really, really, really understand doing electrical systems that ignite pyrotechnics, then you should not be doing this.

There are numerous examples of stuff going off while on the ground. Everybody has had it happen. I even had it happen. Granted, in my case, it was absolute stupidity on my part.

I've got a system that is optically isolated against static, so that there is actually no electrical signal that goes from the timing side of my computer to the firing side. The signal goes through the light and then gets picked up as a light signal by the other side, then that turns on a switch that allows it to fire. That is designed so I can send a static shock through the computer that would destroy the computer and it still won't fire the pyro.

This is particularly important because, on a windy day, a fiberglass airplane picks up so much static electricity that — when you walk up and touch it — it will knock your shoes off. I live in the dry, dusty Southwest and — on a cold, dry day, when it's really windy and there's a lot of dust — you've got millions and millions of volts on an airplane just sitting on the ground. So I had a really good electronics guy build my computer with this in mind.

The first thing it does when you turn on the computer is look for voltage on the firing circuit. If it sees any voltage there, the

computer will not turn on. I get an error message with the lights flashing.

Once I was at a show and I ran a quick test on everything and got this lockup message. So I spent a whole day trying to figure it out and I never did. So when it was time to do the show I said, "All I can do is to put the pyro on and push out to a safe place by the runway and I'm going to hook it up and I'm going to turn on the switches and see what happens." I turned on the computer and it went into lockup. Then I flipped the switch about eight times, fast.

It was a stupid thing to do. The computer was telling me that I had a problem, but I was desperate. Then I had one device go off on the ground. The computer had done everything that I had designed it to do and, stupid me, I kept messing with it until I defeated my own system. Then I got this feeling, "Oh my gosh! How stupid was that?" So I turned everything off, got out of the plane, disconnected the wingtips and pushed it back in the hangar.

As it turns out, the problem was these little black, plastic terminal strips with screws and a whole bunch of wires. Every plane has these, somewhere, and because I run the smoke canisters on the wingtips and there are some metallic elements to the smoke, that plastic had absorbed enough metallic smoke so that the plastic became a conductor. Even washing them didn't help.

At first, I thought that maybe I had residue on them, so I scrubbed them with a toothbrush and still they had enough conductivity from the powder burned into that plastic that they became a conductor. It was like two volts out of 28. That is the sort of thing you have to be aware of when you are doing pyro; little things like plastic parts become conductors under certain conditions. There are so many ways electrons can find their way to your pyro when you don't want them to.

The other thing that most people don't realize is that, when you are transporting this stuff, there are some pretty strict rules on owning and transporting it, depending on what type of materials you have. You will get into trouble if you don't know these rules.

There are three or four entities that control pyrotechnics shipping. Obviously; ATF (Alcohol, Tobacco and Firearms); they control storage and ownership. DOT (Department of Transportation) controls transportation and UN (United Nations) controls the classification. They are all interrelated. So, you will have an ATF regulation that specifies certain exemptions by a UN number. ATF only recognizes two things: high explosive and low explosive. But there are certain things that have certain rules that are regulated by their UN number. There are certain areas where DOT and UN regulations cross, so you have to know all three of those things. You have to know which set of qualifications they are talking about.

You find this out by going to the ATF website and downloading their book. You go to DOT and download their book. And, luckily,



The most dangerous part of flying at night is taxiing on an air show airport in the dark.



the DOT [book] has all the UN stuff in it. The DOT book is about 600 pages and you'd better know it all, because — if you get stopped — interstate commerce with hazardous materials without the right [documentation] is pretty serious.

The first time I did a night show, it was in my Skybolt. It had pyro and strobe lights between two white wings. It was insane. Luckily, I am not susceptible to flicker vertigo. It made all kinds of patterns. I was blind as a bat when I landed. The trick is that you need to have a lighted runway under you as your primary reference. It is the only reference you can count on always being there. Usually, there is a horizon of some sort, but that runway is really your lifeline and you should be familiar enough with your aircraft so you can do your entire routine with your eyes closed. If you can't go up and put a safety pilot on board and do half your routine without opening your eyes and come out reasonably close to where you thought you were, you have the wrong aircraft for doing a night show. If you've got a new airplane and are not comfortable in it, then don't do night pyro in it.

The big issues are just airspeed and altitude. Those are the only two things that matter. And airspeed is not as obvious at night as it is during the day. Your airspeed indicator needs to be in your scan a lot more than in the day. And then there is the weather. The good news is that the weather is usually a little nicer than during the day. You are limited to 500 foot altitude by the rules. So you are not flying down in the weeds.

On choreography: no one can see your airplane. So, if you are pushing six negative Gs at night, you are just being an idiot. I do a thing where I just go out and wing wobble back and forth, just left and right turns, 45 degrees and I'll have people say, "Man you did that tumbling thing!" They suppose the plane is going end over end, because there are all these optical illusions from the pyro crossing and stuff. The audience doesn't know what the heck you are doing up there. So keep it simple and low G and, again, the kind of stuff you could do with your eyes closed.

But the most dangerous part of flying at night is taxiing on an air show airport in the dark. I am so much more scared taxiing in than I am when I am airborne because the lights are turned off and sometimes runways are closed, barriers are up in places you

don't expect them and, unlike during the day show, things are not as well defined. Sometimes, the night show line is different from the day show line. They'll have you fly in a whole different place because you are doing it for the sponsor party or something. So, if you haven't flown the line during the day, at least try to get up and make a few passes along whatever line you are going to fly at night.

Bill Leff

It is really difficult to do the night show without a ground crew. I have to have somebody on the ground to work the lights and everything is a lot easier with a ground crew. There is all this detail work for the night show. You have to spend hours loading and securing the fireworks. It used to take me eight hours, but now three of us can do it in about two or three hours. I've made innovations to simplify it. Once things are wired, it goes through a fire control system that was designed by an actual fire control guy that did Defense Department stuff. It hooks up the connectors and sequences them and protects them so they won't inadvertently fire. I've never had an incident on the ground because of this system. And there is a firewall at the wingtip.

The whole unit comes off with four bolts and three connectors. So I can load it up, take it off and sit it on the ground, go fly a day show, land, four bolts and three connectors and I'm ready to do a night show.

WING WALKING

Greg Shelton

My biggest worries have been engine failures and hitting the wing walker with a bird. I've always kept my routine above 200 feet, which keeps you out of most of the small bird traffic.

When I used to crop dust, going across the field really low, I've hit numerous birds, so I figured – if I kept her above 200 feet – that keeps you about 100 feet above the trees and most of the birds don't go that high. Blackbirds going cross country don't get very high. But I do worry about the hawks and seagulls. They're up higher.

As far as wing walking, you are just flying a terrible performing airplane. You are just flying something that is terribly underpowered. The first time I went up to Colorado Springs, which is about 6,500 feet, and did the show, on the first practice day, I started everything 1,500 feet higher. And I did my full routine, which was a mistake. It took 30 minutes to do what was a 15 minute show. Later, I just settled on being 750 higher.

You just have to stop and climb to that extra altitude, then dive in and start everything a little higher than you've ever done. And your engine is not making as much power.

You have to be careful about Cuban eights at altitude. You need to start the first half higher because you are going to have to run it lower to the ground to have enough speed to do the second half. But anyway, at Denver, I ended up leaving out some of my snap rolls because they are just an energy killer.

The last time I did a high altitude show, I left out every maneuver with Ashley between the wings. Take off, get your altitude, have her climb up on the rack and have at it. That cuts it down to about 15 minutes. Much more than that, and people are bored.

I had the engine quit once with Ashley on top of the wing and we just lucked out. The 500 foot line was the taxiway and I was making the last pass and she was waving at the crowd. We were going down that 500 foot line and when I pushed the throttle up, it just quit. Two, three, four seconds and I am on the ground. We landed on the taxiway.

The thing is that that the airplane is so underpowered that you would just like to be able to avoid turning around over trees, but you just can't do it. You've got to take the risk. If it had quit 15, 20 seconds earlier we would have been in the trees.

Craig Hoskings

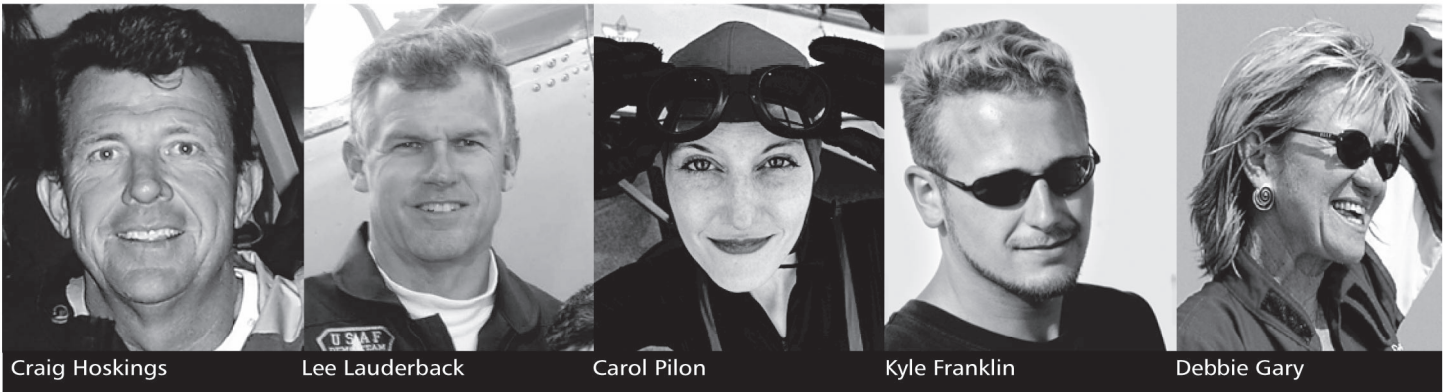
Craig Hoskings was landing in a crosswind after his wing walk act one day when he lost the brake pad on the left wheel, the same side where his wing walker, Lori Ross, was.

I wheel landed and everything was great and I went for the brakes as we started to slow down. I had my tail in the air with Lori on the javelin on the left wing. The right brake grabbed and the left brake didn't. I got the tail on the ground to try to hold it on the runway. Then I went for the throttle and the big, old motor was slow on coming up with the power. By that time, the ground loop was on and it ran off the runway. The left wing dug in and the airplane came up on its nose. As it was on its nose, Lori jumped off and the plane went over and buried the wing rack in about four inches of mud, bent the rack and stopped. It was basically sitting on the nose cowling, the prop and the rack. Lori went scampering away safely. She was fine and I was fine. Later, an FAA inspector found the brake pad on the runway where it had fallen off.

Debbie Gary

A wing walking act is a partnership. For a safe and entertaining act, you've got to have the right wing walker, the right airplane and the right frame of mind. Your mission is to display and protect your wing walker. They come first and you need to be in constant communication through visual signals and cues.

The wing rack adds a lot of drag and the wing walker adds even more. They limit your climb capability, your speed, your acceleration, and how many Gs you can pull, especially when they are loose or moving around the airplane. Raindrops, bugs, birds,



turbulence, crosswinds, bad brakes and off-airport landings present problems you do not have in a solo act.

When wing walkers wear safety restraints, they need to be sure that they are not excessively long and that they do not get caught on parts of the airplane as they move around. If they were to slip, the cable needs to be short enough so the wing walker's hands are still in contact with the plane.

Once, Jim Franklin and stuntman Lee Oman were performing a wing walk on a media flight in which Oman performed under the airplane while hanging from a bar between the gear legs. Franklin could observe him through a window in the belly. It was a cold, wet, tiring flight and Oman slipped. Since he had made his safety cable too long, he fell too far to reach the bar to pull himself back up. Franklin and a crew on the ground in a pickup truck, driven by Bud Granley, then performed a heroic rescue. Using skills he had honed from flying car to plane transfers, Franklin dangled Oman above the pickup truck bed as Granley sped down the runway. Miraculously, someone in the pickup truck was able to cut the nylon webbing from Oman's waist and release him from the steel cable before the truck ran off the runway.

In 2001, Jimmy Franklin trained me to fly a wing walking act in his 450hp Waco Mystery Ship. This is some of the advice from him and his two wing walkers, Kyle Franklin and Carol Pilon. Kyle and Carol each performed on Jimmy's Jet Waco, as well as on the Waco Mystery Ship, so some of their experiences were pretty extreme due to the fact that the Jet Waco never ran out of steam, slowed down and never gave them time to rest between maneuvers.

We took off with the wing walker on the javelin between the two left wings and kept the maneuvers smooth, gentle and positive G when the wing walker was unstrapped and laying on the skinny javelin.

On take-off with a crosswind from the wrong direction (opposite side from where the wing walker is), if you try to get off the ground too slow, you'll run out of aileron. On landing, if the crosswind is really bad and coming from the wrong side, the wing

walker needs to be inside. In a crosswind from the right (with the wing walker on the left side), the wind has more of a tendency to get the left wing down, because the weight is there, and you are already using an awful lot of opposite aileron. If there is ever any doubt, they should be inside the cockpit.

Kyle Franklin

Once, we did a show at Wichita when it was raining on and off. There was a thousand foot ceiling and no one else flew, but we went up. It felt like flying through needles. When we landed, I had red dots all over my face.

And bugs feel like stones hitting you. One weekend, there was a big swarm of Japanese beetles low to the ground. Every time we got within 20 feet of the ground on a low pass, I got pelted by those bugs. It was like being in front of a firing squad. But a bird strike would be much worse. It is bad enough when a bird hits the airplane, but if it struck a wing walker, it would be like a cannonball.

Turbulence is also something you have to think about. When you move around, don't let go with one hand until you've got a really good grip with the other because – if the plane hits turbulence – it could bump you off the plane.

When you are on the top wing, standing completely vertical, the G loads go all the way down to your feet and, if they are too high, they can black you out.

Carol Pilon

Physical endurance is what wing walking is all about, kind of like running track. The hardest place is on the top wing, up in the rack because of all the buffeting pressure on your body. As the speed builds up, sometimes, you have enormous pressures working on you and you have to go into shallow breathing so you can suck air fast enough for your body.

You have to resist the pressure of the wind, which can cause substantial damage to your body if you ever relax. The wind would snap your neck or pull your arm out of its socket.

